Site: Medley FARM
Break: 6.4

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MEDLEY FARM SITE
GAFFNEY, SOUTH CAROLINA

REMEDIAL DESIGN AND REMEDIAL ACTION

REMEDIAL DESIGN WORK PLAN

June 1992

Revised August 1992

Prepared for the
Medley Farm Site Steering Committee

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Section 1

INTRODUCTION

1.1 Background

On May 29, 1991, the United States Environmental Protection Agency (US EPA) issued its Record of Decision (ROD) for the Medley Farm Superfund Site. This document set forth the Agency's rationale and selected remedy for addressing contaminated ground water and soils identified at the site. The ROD for the Medley Farm Site is based upon the findings of the Remedial Investigation/Feasibility Study (RI/FS) conducted by Sirrine Environmental Consultants and comprises one of the primary reference documents that will be used during both the Remedial Design (RD) and Remedial Action (RA).

On October 9, 1991, the Settling Defendants for the Medley Farm Site (hereinafter referred to as the Medley Farm Site Steering Committee) formally entered into a Consent Decree outlining the basis for Remedial Design and Remedial Action at the site. The Consent Decree was formally entered with the United States District Court on January 17, 1992.

The Medley Farm Site RD/RA Consent Decree and Scope of Work outline the work for the RD/RA and establishes specific technical and legal requirements. This Remedial Design Work Plan has been prepared in accordance with the Medley Farm ROD, Consent Decree, and Scope of Work.

1.2 Purpose and Scope

The purpose of this work plan is to outline the overall strategy, approach, and schedule for the development and design of the ROD-selected remedy. Remedial Design is defined in Appendix B of the Medley Farm Consent Decree as "...those activities to be undertaken by the Settling Defendants to develop the final plans and specifications, general provisions and special requirements necessary to translate the Record of Decision (ROD) into the remedy to be constructed under the Remedial Action (RA) phase."

The scope of this work plan is to describe the various design processes, design deliverables, and project schedule under which the Remedial Design activities will be conducted. The Remedial Design

Work Plan will become an enforceable part of the Medley Farm RD/RA Consent Decree upon the Medley Farm Site Steering Committee's receipt of US EPA's written approval of this work plan.

Section 2
SUMMARY OF PROJECT HISTORY

2.1 Description of Site

The Medley Farm Superfund Site (Site) is located approximately six miles south of Gaffney, South Carolina in Cherokee County. The Site is located near County Road 72 as shown in Figure 2-1. The Site comprises approximately 7 acres of a 62-acre parcel that is currently owned by Mr. Ralph Medley. The general property boundaries are shown on Plate 1 (Appendix A).

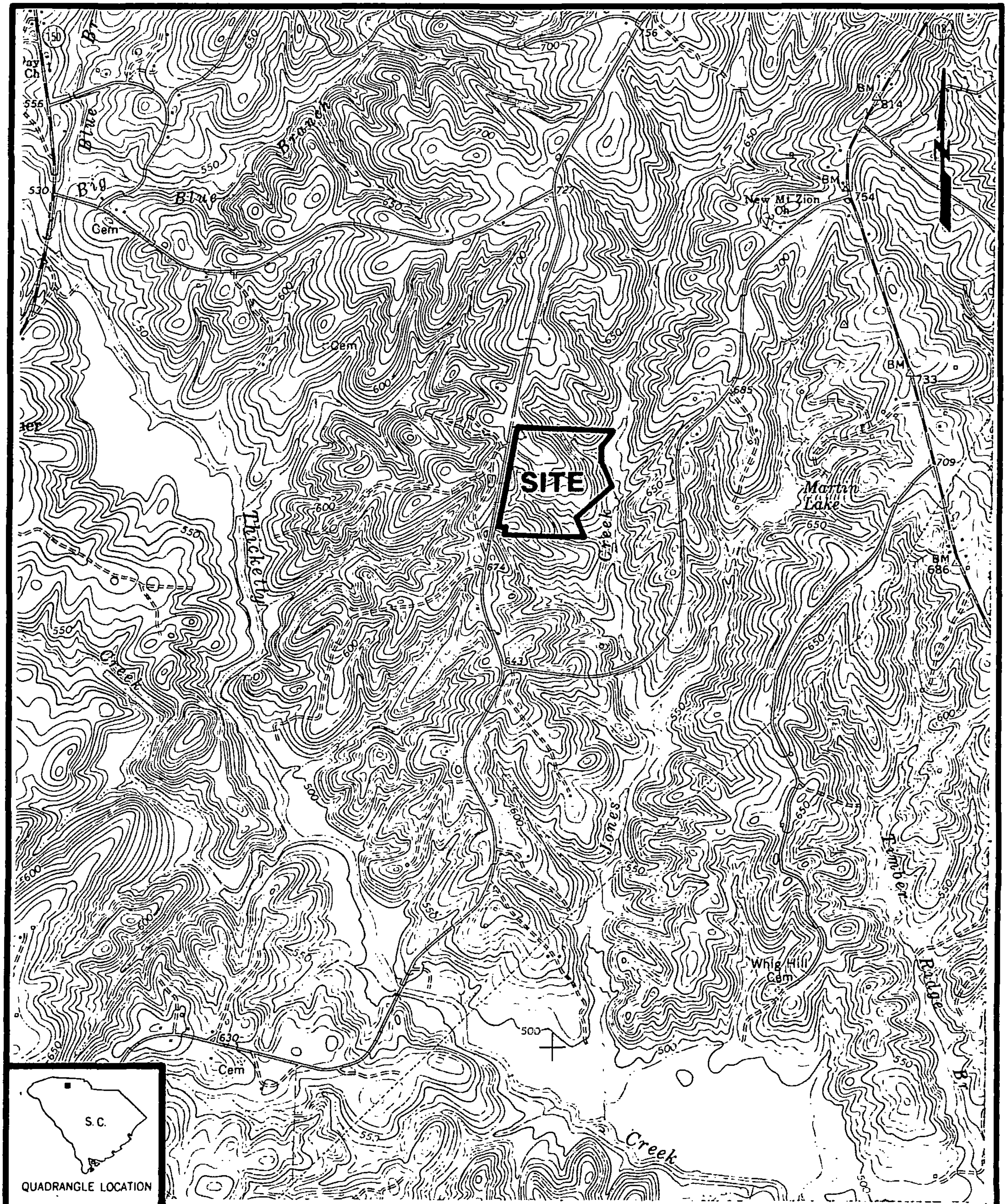
The surrounding land is composed of undeveloped woodlands and pasture. The primary use of these lands is agricultural (small farms and cattle) with light residential interspersed.

The Site is situated along a gently dipping ridge. East and west of the Site, the land drops off steeply to two intermittent streams located on either side of the ridge-line. Surface drainage at the Site occurs to the northeast, east, southeast, south, and southwest. Surface water eventually discharges into Jones Creek, which in turn flows into Thickety Creek. The base flow of Jones Creek is estimated to be approximately 0.45 cubic feet per second (reference: USEPA Record of Decision, 1991).

2.2 Past Site Waste Management Practices

Prior to the mid 1970's, the Medley Farm property was primarily comprised of undeveloped woodlands and pasture. From 1973 to 1976, drummed wastes and other solid waste debris were transported and disposed of at the Site. During a 1983 South Carolina Department of Health and Environmental Control (SC DHEC) inspection of the Site, drum storage areas and six lagoons were discovered on the Site. Figure 2-2 shows the condition of the Medley Farm Site prior to 1983 US EPA emergency response activities.

Following the SC DHEC inspection visit, the US EPA initiated an emergency removal action in June 1983, which resulted in more than 5,000 drums and 2,000 cubic yards of affected soil being removed from the Site and transported to permitted facilities for off-site treatment and/or disposal. Approximately 70,000 gallons of water were drained from the six lagoons located on-site and processed through a pressurized filtration system employing activated carbon for removal of organics. Treated effluent was



PACOLET MILLS QUAD.

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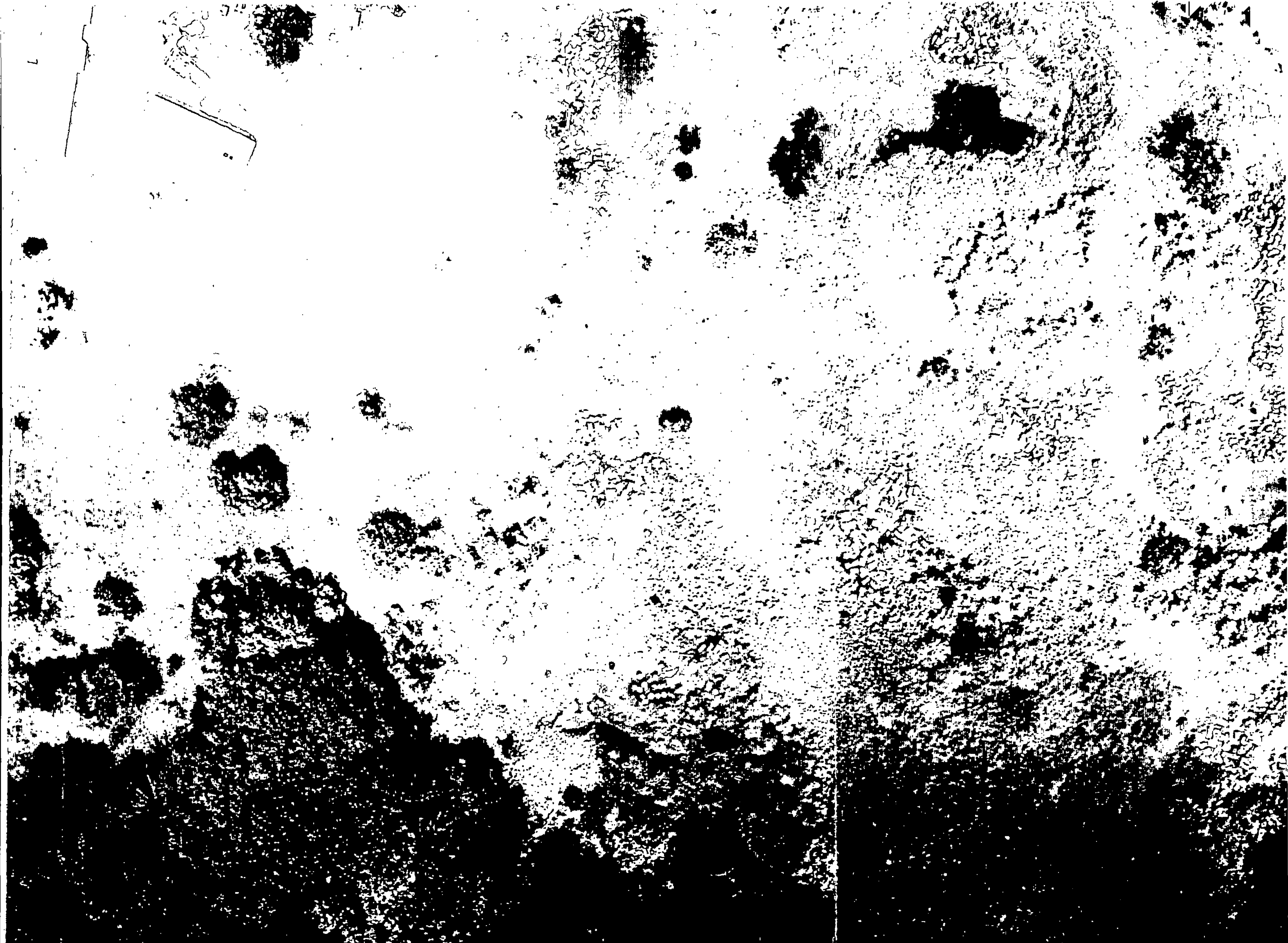
FIGURE 1-1

SITE LOCATION MAP

SCALE: 1"=2000'

MEDLEY FARMS
GAFFNEY, SC.



analyzed to ensure that State discharge standards were achieved prior to release into Jones Creek (USEPA Record of Decision, 1991). Analysis of the drum and lagoon contents confirmed the presence of toluene, benzene, methylene chloride, perchloroethylene, and vinyl chloride. Figure 2-3 shows the condition of the Medley Farm Site immediately following completion of these interim response actions. The Site was first proposed for inclusion on the National Priority List (NPL) in June 1986 and the NPL listing was subsequently finalized in March 1990. The Remedial Investigation/Feasibility Study (RI/FS) for the Site was initiated in 1988 and the draft reports submitted to the Agency in November and December 1990, respectively. The Agency issued its approval of both documents in May 1991. The Medley Farm ROD was issued by the Agency on May 29, 1991.

2.3 Constituents of Concern

The Medley Farm RI identified the presence of volatile organic compounds (VOCs) in the underlying saprolite and bedrock units. The RI further indicated the presence of isolated occurrences of VOCs and semi-volatile organic compounds (SVOCs) in the unsaturated zone soils where several former lagoons were once located. The RI risk assessment indicated that the observed concentrations of VOCs and SVOCs in the unsaturated soils posed no health threat. Remediation of these soils was only included in the ROD to address a possible long-term contaminant source to the ground water.

VOCs were detected in 12 of the site monitoring wells during the RI. These findings have been confirmed during the quarterly monitoring program implemented following entry of the RD/RA Consent Decree. The extent of site-related chemicals in the surface soils is limited to the former disposal area. There are no indications of Constituents of Concern (COCs) in the stream sediments or surface water of the intermittent tributaries. The chemicals shown in Table 2-1 are a comprehensive listing of the chemical constituents detected at or above the CRQL, at least once, in a given environmental media. The chemicals described in Table 2-1 were identified as the primary constituents of concern at the Medley Farm Site.

2.4 Environmental Setting

The discussion that follows is based on information contained in the Medley Farm RI/FS report prepared by Sirrine Environmental Consultants and the US EPA's Record of Decision. Site stratigraphy is illustrated on cross-sections A-A', B-B', C-C', and D-D', which are included as Plates 2, 3, and 4 (Appendix A).

TABLE 2-1

CHEMICALS OF POTENTIAL CONCERN FOR MEDLEY FARM SITE BY MEDIUM*

	Surface Soils	Ground Water (Saprolite)	Ground Water (Bedrock)
Volatile Organic Compounds			
1,1-Dichloroethene		X	X
1,1-Dichloroethane		X	
1,1,1-Trichloroethane		X	X
1,1,2-Trichloroethane	X	X	
1,1,2,2-Tetrachloroethane	X		
1,2-Dichloroethane			x
1,2-Dichloroethene (total)	X	X	x
1,2-Dichloropropane	X		
2-Butanone			X
Acetone			X
Benzene			X
Chloroform			X
Chloromethane		X	
Ethylbenzene	X		
Methylene Chloride	X	X	X
Styrene	X		
Tetrachloroethene	X	X	X
Trichloroethene	X	X	X
Vinyl Chloride	X		
Semi-volatile Organic Compounds			
1,2,4-Trichlorobenzene	X		
Butylbenzylphthalate	X		
Di-n-butylphthalate	X		
Di-n-octylphthalate	X		
bis(2-Ethylhexyl)phthalate	X		

X - Denotes Chemical Detected in Medium

*** - Reference: US EPA Record of Decision, Medley Farm Site, 1991.**

2.4.1 Site Geology

Residual soil at the Site is absent or occurs as a thin layer overlying the saprolite. This soil layer ranges in thickness from zero to 11 feet and typically consists of clayey silt with varying amounts of fine sand, clay, silt/silty clay fill. The fill was probably placed on-site during the 1983 immediate removal action and Site cleanup. Fill material and residual soil are not significant in terms of overall Site geology.

The saprolite is relatively thick across the Site, ranging in thickness from 50 to 70 feet near the former disposal areas to 7 to 28 feet along Jones Creek at the eastern boundary of the property. The lithologic characteristics of the saprolite are similar to the residual soils and are relatively consistent both vertically and horizontally. Saprolite observed in borings drilled at the Site consists predominantly of a silt with varying amounts of fine to coarse sand, clay, mica flakes, and quartz gravel. The saprolite grades downward into rock-type transitional between saprolite and bedrock. This interval is loosely defined by split-spoon refusal (i.e., N750). The thickness of the transition zone averages approximately 15 feet thick.

Site bedrock was investigated by continuous coring at numerous locations. The bedrock consists primarily of a gneiss that varies from a schistose gneiss to a quartzo-feldspathic and quartz-amphibole gneiss. The bedrock is predominantly hard, slightly weathered to fresh, gray, and fine to medium-grained, with closely to moderately-closely (0.5 to 2.5 feet) spaced joints. The joints tend to be smooth to rough and moderately dipping (35 to 55 degrees). Foliation of the bedrock is moderately dipping (35 to 55 degrees) to steep (55 to 85 degrees). Evidence of ground water movement through the bedrock was observed in the form of iron oxide staining along joint surface.

As illustrated in Plate 5 (Appendix A) and in the accompanying hydrogeologic cross-sections, the configuration of the top of the bedrock surface approximates the shape of the topographic surface. As shown on the map depicting the configuration of the top of bedrock (Plate 5), a northeast-southwest trending bedrock high exists at the downgradient edge of the former disposal area. The bedrock high is centered on wells BW-109 and BW-2. To the northwest, beneath the former disposal areas, the surface of the bedrock is lower. The configuration of bedrock may, in part, control the distribution of VOCs in the ground water.

2.4.2 Site Hydrogeology

Ground water at the Medley Farm Site occurs in the saprolite, in the zone of highly fractured and weathered bedrock zone (identified as the transition zone), and in moderately fractured bedrock underlying the Site. Depth to ground water at the Site varies from a depth of 56 to 68 feet in the disposal area, decreasing to six to eight feet near Jones Creek.

In general, ground water flow occurs through both porous and fractured media at the Medley Farm Site. The water table generally occurs in the saprolite across most of the Medley Farm property, with the saprolite serving as a porous medium for ground water flow. In the vicinity of BW-2 and SW-109, located at the eastern edge of the former disposal area and along the previously described bedrock high, the water table occurs in the bedrock transition zone. Although the ground water occurring in the saprolite and bedrock is part of interconnected water bearing units, ground water within the bedrock at the Site is present under semi-confined to confined conditions.

According to data presented in the Medley Farm RI Report, hydraulic conductivity values for wells screened in the saprolite range from 3×10^{-3} to 3×10^{-5} cm/sec. With the exception of the deep bedrock wells (BW-112), hydraulic conductivity values estimated in wells screened in fractured bedrock range from 7×10^{-5} to 4×10^{-3} cm/sec. Hydraulic conductivity values for the deep bedrock wells were estimated at approximately 10^{-7} cm/sec.

Yields from wells completed in the saprolite are generally very low. Yields from bedrock wells are relatively high, but depend on the nature, quantity, and interconnection of the secondary (fracture) porosity and well encounters. The bedrock wells completed in the moderately fractured bedrock at the Site demonstrate relatively high yields (5-7 gpm). Ground water in the saprolite wells, however, can be completely evacuated with a bailer requiring several hours for complete recovery of the well.

Ground water flow at the Medley Farm Site occurs primarily to the southeast towards Jones Creek, as shown in Plate 6 (Appendix A). The hydraulic gradient averages approximately 0.044 ft/ft across the Site. The calculated horizontal ground water flow velocities are estimated to range from 1.1 feet/day (402 feet/year) to 1.3 feet/day (475 feet/year) for the saprolite.

Water level measurements made in May 1992 from the six saprolite/bedrock well clusters indicate both upward and downward vertical hydraulic gradients of varying magnitude. Positive or upward vertical gradients were observed at monitoring well clusters SW-106/BW-106 and PZ-1/BW-3. Negative or downward vertical gradients were observed at monitoring well clusters SW-1/BW-1, SW-4/BW-105, BW-108/SW-108 and BW-109/SW-109.

Jones Creek and its tributaries serve as zones of ground water discharge from the Medley Farm Site. Base flow in Jones Creek at the Site is reported approximately 0.45 cfs (US EPA Record of Decision, 1991). During the RI field activities, water levels in the saprolite and bedrock adjacent to Jones Creek (PZ-1 and BW-3) were consistently above water levels measured during RI field activities observed in the tributary at staff gauge SL-3. The water level in BW-106 is greater than the water level observed in the tributary at staff gauge SL-5. However, the water level in SW-106 is less than the water level observed at staff gauge SL-5, indicating localized surface water recharge to the saprolite aquifer at this location.

2.5 Affected Media

Data collected during the RI has shown that surface soil, subsurface soil, and ground water have been affected by past waste disposal activities. Analytical results obtained from surface water and stream sediment samples collected during the RI did not detect waste constituents. This was confirmed by additional sampling conducted during the February 1992 quarterly sampling episode.

2.5.1 Surface Soil Results

VOCs and SVOCs have been detected in surface soil samples. Plate 1 shows the locations where the surface soil samples were collected. In addition to VOCs and SVOCs, PCBs were also detected in several surface soil samples. Except for sample HA-11, these samples were collected from within the limits of the former disposal area on-site. Sample HA-11 was located in a position that receives sediment runoff from the site. Dieldrin was detected in Test Pit 5 and trace levels of toxaphene were identified in sample HA-1. These constituents were detected at levels below US EPA action levels. For this reason, no remedial response is anticipated.

2.5.2 Subsurface Soil Results

No vertical pattern of chemical distribution in subsurface soils is apparent. Elevated concentrations of waste constituents were generally found at depths less than 17 feet. Elevated concentrations of VOCs were noted at depths of 27 feet in soil borings SB-2, SB-4, and SB-9. Subsurface soil sampling locations are shown on Plate 1 (Appendix A). Analytical data for subsurface soils are summarized on Table 2-2.

2.5.3 Ground Water Results

Elevated concentrations of VOCs have been detected in the ground water beneath the site. SVOCs have not been detected in the ground water. Ground water sampling locations are shown on Plate 1 (Appendix A). Analytical data obtained during the February 1992 sampling episode are summarized in Table 2-3. SVOCs have since been deleted from the quarterly monitoring program by the US EPA.

2.5.4 Surface Water Results

In accordance with the Medley Farm Statement of Work (SOW), two surface water samples (RW-5 and RW-6) were collected from the unnamed tributaries of Jones Creek that drain the site from the northeast and southeast. Surface water sampling locations are shown on Plate 1 of Appendix A. Analytical results from the first quarterly sampling episode conducted in February 1992 identified trichloroethene and tetrachloroethene below method detection limits at concentrations of 0.005 and 0.003 ppm, respectively. These results will be substantiated in an upcoming quarterly sampling event. Based on the results of the confirmation analyses, a decision will be made regarding the need to continue monitoring surface water at the site.

2.6 Constituent Transport and Fate

Although there is not a uniform distribution of waste constituents in the vadose soil, residual concentrations are concentrated in localized areas associated with the former drum disposal areas or lagoons. These are the areas of the site identified by the ROD as requiring soil vapor extraction.

Due to the lack of steep topography in the immediate disposal areas, the vegetative cover, and the nature of chemical residuals at the site, overland migration of waste constituents has not been

TABLE 2-2

SUMMARY OF ORGANIC COMPOUNDS DETECTED IN SUBSURFACE SOIL[a,b]

MEDLEY FARM SITE

COMPOUND[c]	SB-2 Depth Below Surface (feet)				SB-3 Depth Below Surface (feet)			
	5-7	10-12	15-17	25-27	5-7	10-12	15-17	25-27
VOLATILE ORGANIC COMPOUNDS								
1,1,2,2 Tetrachloroethane	NA	0.710	0.097	0.074	NA	ND	ND	ND
Chloroform	NA	0.600	ND	ND	NA	ND	ND	ND
1,2-Dichloroethane	NA	ND	ND	ND	NA	ND	ND	ND
Methylene Chloride	NA	ND	ND	ND	NA	0.050	ND	ND
Trichloroethene	NA	ND	ND	ND	NA	ND	ND	ND
Acetone	NA	18.0	7.3	0.750	NA	0.140	0.055	0.016
SEMIVOLATILE ORGANIC COMPOUNDS								
1,2-Dichlorobenzene	NA	ND	ND	ND	NA	ND	0.460	ND
Naphthalene	NA	ND	ND	ND	NA	ND	0.410	ND
Phenol	NA	77.0	ND	0.690	NA	ND	ND	ND
1,4-Dichlorobenzene	NA	ND	ND	ND	NA	ND	2.300	ND
Diethylphthalate	NA	ND	ND	ND	NA	ND	ND	3.200
Benzoic Acid	NA	ND	ND	2.600	NA	ND	ND	ND
1,2,4-Trichlorobenzene	NA	ND	ND	5.200	NA	0.700	12.00	ND

a Analytical data taken from RI/FS prepared by Sirrine Environmental Consultants.
b Analytical results are reported in parts per million (PPM).
c Compounds detected in subsurface soil samples.
NA Sample not analyzed.
ND Compound not detected at or above the practical quantitation limit.
Note: Shaded blocks indicate concentrations above potential remediation level.

TABLE 2-2 (CONT.)
SUMMARY OF ORGANIC COMPOUNDS DETECTED IN SUBSURFACE SOIL[a,b]
MEDLEY FARM SITE

COMPOUND[c]	SB-4 Depth Below Surface (feet)				SB-5 Depth Below Surface (feet)			
	5-7	10-12	15-17	25-27	5-7	10-12	15-17	25-27
VOLATILE ORGANIC COMPOUNDS								
1,1,2,2 Tetrachloroethane	NA	ND	ND	ND	ND	ND	0.009	ND
Chloroform	NA	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	NA	3.700	4.500	0.680	ND	ND	ND	ND
Methylene Chloride	NA	0.010	0.032	0.017	ND	ND	ND	ND
Trichloroethene	NA	0.019	0.032	0.017	ND	ND	ND	ND
Acetone	NA	0.200	1.900	0.100	ND	0.021	0.570	ND
SEMIVOLATILE ORGANIC COMPOUNDS								
1,2-Dichlorobenzene	NA	ND	ND	ND	ND	ND	ND	ND
Naphthalene	NA	ND	ND	ND	ND	ND	ND	ND
Phenol	NA	ND	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	NA	ND	ND	ND	ND	ND	ND	ND
Diethylphthalate	NA	ND	ND	ND	ND	ND	ND	ND
Benzoic Acid	NA	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	NA	ND	ND	ND	ND	ND	ND	ND

a Analytical data taken from RI/FS prepared by Sirrine Environmental Consultants.
b Analytical results are reported in parts per million (PPM).
c Compounds detected in subsurface soil samples.
NA Sample not analyzed.
ND Compound not detected at or above the practical quantitation limit.
Note: Shaded blocks indicate concentrations above potential remediation level.

TABLE 2-2 (CONT.)

SUMMARY OF ORGANIC COMPOUNDS DETECTED IN SUBSURFACE SOIL[a,b]

MEDLEY FARM SITE

COMPOUND[c]	SB-6				SB-7			
	Depth Below Surface (feet)				Depth Below Surface (feet)			
	5-7	10-12	15-17	25-27	5-7	10-12	15-17	25-27
VOLATILE ORGANIC COMPOUNDS								
1,1,2,2 Tetrachloroethane	0.006	NA	ND	ND	ND	NA	ND	ND
Chloroform	0.013	NA	ND	ND	ND	NA	ND	ND
1,2-Dichloroethane	ND	NA	ND	ND	0.097	NA	ND	ND
Methylene Chloride	ND	NA	ND	ND	ND	NA	ND	ND
Trichloroethene	ND	NA	ND	ND	0.024	NA	ND	ND
Acetone	0.058	NA	ND	ND	4.700	NA	0.120	0.018
SEMIVOLATILE ORGANIC COMPOUNDS								
1,2-Dichlorobenzene	ND	NA	ND	ND	ND	NA	ND	ND
Naphthalene	ND	NA	ND	ND	ND	NA	ND	ND
Phenol	ND	NA	ND	ND	ND	NA	ND	ND
1,4-Dichlorobenzene	ND	NA	ND	ND	ND	NA	ND	ND
Diethylphthalate	ND	NA	ND	ND	ND	NA	ND	ND
Benzoic Acid	ND	NA	ND	ND	ND	NA	ND	ND
1,2,4-Trichlorobenzene	ND	NA	ND	ND	ND	NA	ND	ND

a Analytical data taken from RI/FS prepared by Sirrine Environmental Consultants.
b Analytical results are reported in parts per million (PPM).
c Compounds detected in subsurface soil samples.
NA Sample not analyzed.
ND Compound not detected at or above the practical quantitation limit.
Note: Shaded blocks indicate concentrations above potential remediation level.

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TABLE 2-2 (CONT.)
SUMMARY OF ORGANIC COMPOUNDS DETECTED IN SUBSURFACE SOIL[a,b]
MEDLEY FARM SITE

COMPOUND[c]	SB-8				SB-9			
	Depth Below Surface (feet)				Depth Below Surface (feet)			
	5-7	10-12	15-17	25-27	5-7	10-12	15-17	25-27
VOLATILE ORGANIC COMPOUNDS								
1,1,2,2 Tetrachloroethane	ND	NA	ND	ND	NA	ND	ND	ND
Chloroform	ND	NA	ND	ND	NA	ND	ND	ND
1,2-Dichloroethane	ND	NA	ND	ND	NA	0.047	0.032	0.099
Methylene Chloride	ND	NA	ND	ND	NA	ND	ND	ND
Trichloroethene	ND	NA	ND	ND	NA	ND	ND	ND
Acetone	0.086	NA	0.058	0.250	NA	0.094	0.110	ND
SEMIVOLATILE ORGANIC COMPOUNDS								
1,2-Dichlorobenzene	ND	NA	ND	ND	NA	ND	ND	ND
Naphthalene	ND	NA	ND	ND	NA	ND	ND	ND
Phenol	ND	NA	ND	ND	NA	ND	ND	ND
1,4-Dichlorobenzene	ND	NA	ND	ND	NA	ND	ND	ND
Diethylphthalate	ND	NA	ND	ND	NA	ND	ND	ND
Benzoic Acid	ND	NA	ND	ND	NA	ND	ND	ND
1,2,4-Trichlorobenzene	ND	NA	ND	ND	NA	ND	ND	ND

a Analytical data taken from RI/FS prepared by Sirrine Environmental Consultants.
b Analytical results are reported in parts per million (PPM).
c Compounds detected in subsurface soil samples.
NA Sample not analyzed.
ND Compound not detected at or above the practical quantitation limit.
Note: Shaded blocks indicate concentrations above potential remediation level.

TABLE 2-2 (CONT.)

SUMMARY OF ORGANIC COMPOUNDS DETECTED IN SUBSURFACE SOIL[a,b]

MEDLEY FARM SITE

COMPOUND[c]	SB-10 Depth Below Surface (feet)			
	5-7	10-12	15-17	25-27
VOLATILE ORGANIC COMPOUNDS				
1,1,2,2 Tetrachloroethane	ND	NA	ND	ND
Chloroform	ND	NA	ND	ND
1,2-Dichloroethane	0.023	NA	ND	ND
Methylene Chloride	ND	NA	ND	ND
Trichloroethene	ND	NA	ND	ND
Acetone	0.031	0.004	0.040	0.065
SEMIVOLATILE ORGANIC COMPOUNDS				
1,2-Dichlorobenzene	ND	NA	ND	ND
Naphthalene	ND	NA	ND	ND
Phenol	ND	NA	ND	ND
1,4-Dichlorobenzene	ND	NA	ND	ND
Diethylphthalate	ND	NA	ND	ND
Benzoic Acid	ND	NA	ND	ND
1,2,4-Trichlorobenzene	ND	NA	ND	ND

a Analytical data taken from RI/FS prepared by Sirrine Environmental Consultants.
b Analytical results are reported in parts per million (PPM).
c Compounds detected in subsurface soil samples.
NA Sample not analyzed.
ND Compound not detected at or above the practical quantitation limit.
Note: Shaded blocks indicate concentrations above potential remediation level.

TABLE 2-3
QUARTERLY SAMPLING DATA SUMMARY[a]
FEBRUARY 1992
MEDLEY FARM SITE

PARAMETERS	SW01	SW03	SW03 DL	SW04	SW101	SW106	SW108
	19-Feb-92	18-Feb-92	18-Feb-92	18-Feb-92	20-Feb-92	19-Feb-92	17-Feb-92
VOLATILE ORGANIC COMPOUNDS							
Acetone	0.004 BJ	0.006 BJ	<0.025	0.17 BJ	0.007 BJ	0.019 B	<0.010
Benzene	<0.010	<0.010	<0.025	<0.250	<0.010	<0.010	<0.010
2-Butanone	<0.010	<0.010	<0.025	<0.250	<0.010	<0.010	<0.010
Chloroform	<0.010	<0.010	<0.025	<0.250	<0.010	<0.010	0.003 J
1,1-Dichloroethane	<0.010	<0.010	<0.025	0.026 J	<0.010	0.001 J	0.005 J
1,2-Dichloroethane	<0.010	<0.010	<0.025	<0.250	<0.010	<0.010	0.002 J
1,1-Dichloroethene	<0.010	0.0008 J	<0.025	2.3	0.005 J	<0.010	0.016
1,2-Dichloroethene (total)	<0.010	0.003 J	0.002 DJ	0.019 J	<0.010	<0.010	0.006 J
4-Methyl-2-pentanone	<0.010	<0.010	<0.025	<0.250	<0.010	<0.010	<0.010
Tetrachloroethene	<0.010	0.30 E	0.30 D	<0.250	<0.010	<0.010	0.038
Toluene	<0.010	<0.010	<0.025	<0.250	<0.010	<0.010	<0.010
1,1,1-Trichloroethane	<0.010	<0.010	<0.025	2.4	0.002 J	<0.010	0.008 J
1,1,2-Trichloroethane	<0.010	<0.010	<0.025	<0.250	<0.010	<0.010	<0.010
Trichloroethene	<0.010	0.18	0.18 D	0.011 J	0.0005 J	<0.010	0.057
SEMIVOLATILE ORGANIC COMPOUNDS							
bis(2-Ethylhexyl)phthalate		<0.010		<0.010			

a Analytical results are reported in parts per million.
B Analyte present in field blank.
D Dissolved analyte greater than total analyte. Analyses pass QC based on precision criteria.
DL Sample diluted before analyis.
E Elevated detection limit due to matrix effects.
J Estimated concentration.

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TABLE 2-3 (CONT.)
QUARTERLY SAMPLING DATA SUMMARY[a] (CONT.)
FEBRUARY 1992
MEDLEY FARM SITE

PARAMETER	BW01	BW02	DU02	DU02 DL	BW04	BW105	BW106	BW108	BW108 DL
	19-Feb-92	20-Feb-92	20-Feb-92	20-Feb-92	20-Feb-92	18-Feb-92	19-Feb-92	17-Feb-92	17-Feb-92
VOLATILE ORGANIC COMPOUNDS									
Acetone	0.005 BJ	0.030 BJ	0.005 BJ	<0.050	0.004 BJ	<0.010	0.005 BJ	0.020 BJ	0.020 BDJ
Benzene	<0.010	<0.050	<0.010	<0.050	<0.010	<0.010	<0.010	0.001 J	0.001 DJ
2-Butanone	<0.010	<0.050	<0.010	<0.050	<0.010	<0.010	<0.010	<0.025	<0.050
Chloroform	<0.010	0.011 J	0.010	0.012 DJ	<0.010	<0.010	<0.010	0.027	0.031 DJ
1,1-Dichloroethane	<0.010	<0.050	<0.010	<0.050	<0.010	<0.010	<0.010	0.004 J	0.005 DJ
1,2-Dichloroethane	<0.010	0.52	0.50 E	0.55 D	<0.010	<0.010	<0.010	0.015 J	0.017 DJ
1,1-Dichloroethene	<0.010	0.30	0.30 E	0.30 D	<0.010	0.005 J	<0.010	0.19	0.19 D
1,2-Dichloroethene (total)	<0.010	0.003 J	0.003 J	0.003 DJ	<0.010	<0.010	<0.010	0.027	0.028 DJ
4-Methyl-2-pentanone	<0.010	<0.050	<0.010	<0.050	<0.010	0.003 J	<0.010	<0.025	<0.050
Tetrachloroethene	<0.010	0.020 J	0.018	0.020 DJ	<0.010	<0.010	<0.010	0.40	0.48 D
Toluene	<0.010	<0.050	<0.010	<0.050	<0.010	<0.010	<0.010	<0.025	<0.050
1,1,1-Trichloroethane	<0.010	0.17	0.15	0.16 D	<0.010	0.012	0.0006 J	0.11	0.12 D
1,1,2-Trichloroethane	<0.010	<0.050	0.002 J	<0.050	<0.010	<0.010	<0.010	0.001 J	<0.050
Trichloroethene	<0.010	0.63	0.52 E	0.66 D	<0.010	<0.010	<0.010	0.68 E	0.81 D
SEMIVOLATILE ORGANIC COMPOUNDS									
bis(2-Ethylhexyl)phthalate		0.009 J	<0.010			0.006 J			

a Analytical results are reported in parts per million.
B Analyte present in field blank.
D Dissolved analyte greater than total analyte. Analyses pass QC based on precision criteria.
DL Sample diluted before analyis.
E Elevated detection limit due to matrix effects.
J Estimated concentration.

WP\9\93807TB.2-3/cdl92

TABLE 2-3 (CONT.)
QUARTERLY SAMPLING DATA SUMMARY[a] (CONT.)
FEBRUARY 1992
MEDLEY FARM SITE

PARAMETERS	RW05	RW06	DU01	FBLK01	RBLK01	TBLK01	TBLK02
	19-Feb-92	20-Feb-92	20-Feb-92	18-Feb-92	19-Feb-92	17-Feb-92	11-Feb-92
Volatile Organic Compounds							
Acetone	0.009 BJ	0.007 BJ	<0.012	0.006 BJ	0.024 B	0.005 BJ	0.005 BJ
Benzene	<0.010	<0.010	<0.012	<0.010	<0.010	<0.010	<0.010
2-Butanone	<0.010	<0.010	0.003 J	<0.010	<0.010	<0.010	<0.010
Chloroform	<0.010	<0.010	<0.012	<0.010	<0.010	<0.010	<0.010
1,1-Dichloroethane	<0.010	<0.010	<0.012	<0.010	<0.010	<0.010	<0.010
1,2-Dichloroethane	<0.010	<0.010	<0.012	<0.010	<0.010	<0.010	<0.010
1,1-Dichloroethene	<0.010	<0.010	<0.012	<0.010	<0.010	<0.010	<0.010
1,2-Dichloroethene (total)	0.0008 J	<0.010	<0.012	<0.010	<0.010	<0.010	<0.010
4-Methyl-2-pentanone	<0.010	<0.010	<0.012	<0.010	<0.010	<0.010	<0.010
Tetrachloroethene	0.003 J	<0.010	<0.012	<0.010	<0.010	<0.010	<0.010
Toluene	<0.010	<0.010	0.010 J	<0.010	<0.010	<0.010	<0.010
1,1,1-Trichloroethane	0.0007 J	<0.010	<0.012	<0.010	<0.010	<0.010	<0.010
1,1,2-Trichloroethane	<0.010	<0.010	<0.012	<0.010	<0.010	<0.010	<0.010
Trichloroethene	0.005 J	<0.010	<0.012	<0.010	<0.010	<0.010	<0.010
Semivolatile Organic Compounds							
bis(2-Ethylhexyl)phthalate							

a Analytical results are reported in parts per million.
B Analyte present in field blank.
D. Dissolved analyte greater than total analyte. Analyses pass QC based on precision criteria.
DL Sample diluted before analyis.
E Elevated detection limit due to matrix effects.
J Estimated concentration.

WP\9\93807TB.2-3/cdf92

significant. The emergency removal action taken by US EPA (June - July 1983) appears to have successfully removed the major portion of the source material and affected soil.

Ground water quality data indicates that VOCs released at the surface have affected ground water quality on-site. SVOCs have not been detected in monitoring wells on-site. The US EPA has recently deleted SVOCs from the quarterly site monitoring program.
Based on data collected during the RI and the February 1992 sampling episode, the horizontal extent of the VOC plume appears to be limited to the upper portion of the aquifer directly beneath the former disposal areas. The distribution of VOCs appears to be controlled, in part, by the configuration of the top of the bedrock surface. VOCs at concentrations above established action levels have been identified beneath the former disposal areas hydraulically upgradient of the northeast-southwest trending bedrock high centered on wells BW-109 and BW-2. Detectable concentrations of VOCs exist downgradient of the bedrock high; however, these concentrations are below site-specific cleanup targets. The extent of VOCs in the bedrock is comparable to the saprolite wells in that exceedances of cleanup targets are restricted to the uppermost portion of the bedrock hydraulically upgradient of the bedrock high beneath the former disposal area.

2.7 Remedial Action Objectives

The remedial objectives of the remedy described by this work plan are defined by the RD/RA Scope of Work (SOW) and include the following:

- Prevent or mitigate the continued release of hazardous substances to the ground water.
- Eliminate or minimize the potential threats posed to human health and the environment from current and potential migration of hazardous substances in the ground water and subsurface soil at and from the site.
- Reduce concentrations of hazardous substances in the ground water and soils, insofar as it is technically practical, to remediation levels established as Performance Standards, consistent with the ROD and SOW.
- Reduce the volume, toxicity, and mobility of hazardous substances at the site.
- Maintain air quality at protective levels for on-site workers and the public during remediation.

2.8 Selected Remedial Alternatives

This section of the work plan describes the remedial alternatives that are a part of this remedial design, and a brief discussion as to RMT's intentions with respect to design and implementation of these systems.

2.8.1 Soil Vapor Extraction (SVE)

SVE is an effective means of removing VOCs and some SVOCs that become entrained upon unsaturated zone soils. The applied vacuum removes the sorbed organic constituent from the surface of the soil particles into an induced air stream, where it is removed from the soil. The precise areas of the site requiring SVE are described in the ROD.

RMT's approach to SVE at the Medley Farm Site involves the use of transportable vacuum equipment, readily accessible PVC vacuum lines, SVE wells spaced on conservative intervals within the areas of concern and screened down to within 3-5 feet of the mean high water table. RMT's approach to SVE is discussed in the Technical Memorandum presented in Appendix B. Appendix B provides photographs showing trailer-mounted vacuum equipment, PVC vacuum lines running along the ground surface, and manifolded SVE wells.

Our prior experience has shown the approach described in Appendix B to be an effective means of conducting SVE remediation. Vacuum leaks present in the piping are quickly identified by their characteristic shriek. This system benefit results in prompt and effective maintenance. The overall SVE system can also be dismantled quickly after completion of the remedial action.

SVE system effectiveness is best evaluated by the use of in-place U-Tube Manometers. These measurement devices are used to evaluate the areal extent of the applied vacuum. As indicated in our March 6, 1992 Technical Memorandum to the US EPA (Appendix B), pilot testing will be incorporated into the actual SVE well installation procedures to evaluate actual field conditions.

RMT proposes the following approach for implementing the SVE at the site. Active remediation at Medley Farm would first begin with installation and start-up of the SVE system. This is a reasonable first step given the straight-forward nature with which the SVE system can be designed and implemented. Installation of the SVE system also affords an excellent opportunity to collect additional geological information in the area of the postulated "trough", since the SVE systems will be installed in the immediate area of this geologic feature.

Since it is our intention to install SVE wells to a depth near the seasonal high water table, this approach provides an opportunity to collect additional site information and locate the SVE wells at sufficient depth to minimize the possibility of the source control missing smaller "pockets" of VOC/SVOC constituents. RMT geologists will obtain additional site geologic information as the SVE wells are installed, to further define the configuration of the transition zone and bedrock zone as shown on Plate 5 (Appendix A). This crucial information will assist us in further evaluating the existence of this "trough" and more effectively site the location and depth of jet-pump recovery wells. This approach does not influence the Remedial Design process, but only influences the actual sequencing of the Remedial Action.

2.8.2 Jet-Pump Ground Water Extraction

Effective site remediation requires successful integration of proven treatment technologies with a thorough knowledge of site geology, hydrology, contaminant characteristics, and other pertinent site features. The ROD-selected technologies, air-stripping and SVE, are appropriate for addressing the observed site conditions and the nature of the chemical constituents present in the unsaturated soils and ground water of the Medley Farm Site.

By integrating our knowledge of site-specific geologic features noted in the transition zone and bedrock zone (refer to Section 2.4.1), we expect to improve the degree to which the ground water collection system can intercept the affected ground water. The presence of this subsurface "trough" suggests that ground water flow may be channeling through the heart of the former waste disposal area. Water quality results and geologic cross-sections support this interpretation. This interpretation also explains the apparent lack of site COCs in areas where they would be intuitively expected. In the event that this finding can be confirmed, it affords an important opportunity to focus remedial activities on a more discrete and defined portion of the site than might ordinarily be possible.

RMT's approach to ground water collection and treatment has been previously described in our Technical Memorandum to the US EPA, dated March 6, 1992. This document is included in Appendix B for your review and information. Appendix A provides a number of photographs describing prior jet-pump systems and their applicability to sites such as Medley Farm.

In general, it is proposed to utilize the geologic information acquired during installation of the Site SVE wells to develop the likely configuration of jet-pump extraction wells. At this time, the recovery well system is envisioned to be oriented in a manner to intercept ground water flow at or near the MCL plume boundary.

Initially, ground water extraction wells will be designed and installed to the bedrock-transition zone contact. This is an important design feature since we want to be careful to avoid potentially inducing flow of VOCs deeper into bedrock units. We believe that the jet-pump system will be capable of inducing flow out of the upper bedrock units. It will require a period of site operation to confirm this.

Section 3
SUPPLEMENTAL PROJECT ACTIVITIES

3.1 Supplemental Ground Water and Surface Water Quality Assessment

In accordance with the ROD and Consent Decree, supplemental field activities are planned to further characterize ground water quality and monitor existing site ground water and surface water conditions. These supplemental field activities include the following tasks:

- Conduct water quality testing of the site ground water to determine if additional treatment of the ground water is needed to address possible concerns for corrosion, scaling, precipitant formation, or other possible engineering contingencies associated with ground water treatment.
- Collect ground water and surface water samples, on a one-time basis from the on-site monitoring wells and stream monitoring stations to evaluate overall site water quality conditions. Ground water and surface water samples will be collected in accordance with the approved FSAP and QAPP and be analyzed for the volatile portion of the Target Compound List.
- Conduct additional evaluations and/or analytical testing of the ground water and surface water to identify possible inorganic constituents that may require consideration from the perspective of NPDES permit requirements.
- Further define the extent (vertical and horizontal) of the ground water contaminant plume in the northeast direction as described by the FSAP.

These activities will be conducted concurrently with the Remedial Design.

3.2 NPDES Permitting

RMT's approach to obtaining the necessary NPDES permit(s) for this project will occur in two distinct phases. Phase 1 involves completion and submittal of EPA Form 2D (New Sources and New Dischargers: Application For Permit to Discharge Process Wastewater) to SC DHEC for review. In this phase of the permitting process, RMT will develop estimates of the anticipated rate of discharge from the ground water treatment system and the chemical characteristics of the treated ground water. We anticipate that the initial SC DHEC response to the initial permit application will be to prepare a draft permit listing proposed discharge limitations for the prescribed COCs. At this time, the Steering Committee and RMT will evaluate the feasibility of achieving the proposed discharge limitations using the treatment processes required by the ROD. Discharge of treated ground water to one of the nearby streams is envisioned as the desired alternative. Following a 8-10 month (minimum) SC DHEC/Public

Review Process, SC DHEC will issue an operating permit stipulating submittal of the EPA Form 2C application. Herein starts Phase II of the permitting process.

Phase II of the NPDES permit process must be initiated within two years of the ground water treatment system start-up. As actual discharge begins, the treated effluent from the system will be sampled and analyzed for the analytical parameters necessary to complete US EPA Form 2C. This permit package, along with the necessary technical documentation, will once more be submitted for SC DHEC/US EPA review. After submittal of this package, we anticipate entering into another period of negotiations and public review/comment which will ultimately result in the issuance of the five-year NPDES permit for the ground water remediation system.

3.3 Air Emissions

Our preliminary evaluations of likely air emissions from the air stripper and soil vacuum extraction unit leads us to question whether air permits will be required. RMT envisions two possible scenarios for addressing SC DHEC Bureau of Air Quality Control (BAQC) requirements for construction and operating permits for these units. Under the first scenario, RMT would submit a request for waiver of permitting requirements.

RMT's waiver submittal would include VOC emissions estimates previously compiled by Sirrine Environmental Consultants, modelled ambient air concentrations, specific equipment details for both the air stripper and SVE system, and other supporting technical documentation. This information would be provided under cover of a letter describing the proposed field application and the negligible effects posed to surrounding air quality. This waiver package would be sent to the SC DHEC BAQC for their review and consideration. We believe that, after review and consideration of our technical submittal, it is likely that the BAQC will grant our waiver request for this project.

In the event that the BAQC should decide not to grant the waiver request, RMT would then follow normal permitting procedures. SC DHEC BAQC typically requires that applications for construction be submitted at least 90 days prior to the anticipated date of construction. The permit application would include the Part I-General Information Application, Part IIB-Process Permit Application and the Modelling/Air Toxics questionnaire. Following review of this permit application and satisfaction of possible BAQC concerns, the BAQC would then issue the required Permit to Construct, with any applicable air quality restrictions.

The Operating Permit will be issued once the construction of the various treatment units is complete and normal operation begins. BAQC typically requires a letter prior to start-up operations, stating that the units are complete and the date that normal operations will initiate. At that time, BAQC may elect to send an inspector to verify construction of the units in accordance with the permit application prior to issuance of the Operating Permit.

In either event, we believe that the SC DHEC BAQC will not require installation of air pollution control equipment for either of these remediation devices as specified by the ROD. Currently, there has been no requirement for similar remediation equipment operating in South Carolina to be retrofitted with such air pollution control devices.

3.4 Ground Water Capture Zone Analysis

The ground water beneath the site is classified as Class GB in accordance with the South Carolina water classification system and Class IIA under the US EPA Groundwater Classification Guidelines (December 1986). As stated in the ROD, water quality beneath the site must be restored to levels protective of public health and the environment. Site specific cleanup targets established by the ROD are shown on Table 3-1.

According to the Record of Decision (ROD), ground water restoration will be accomplished by "...installing a series of extraction wells located within and at the periphery of the contaminant plume in the saprolite and bedrock portions of the aquifer." To properly locate the extraction wells, several factors must be integrated. These factors include:

- the distribution and concentration of COCs in the ground water,
- the site geology, and
- the hydrologic conditions on-site.

TABLE 3-1

POTENTIAL GROUND WATER REMEDIATION LEVELS*

COMPOUND	REMEDIATION LEVEL (µg/L)	SOURCE
Acetone	350	(a)
Benzene	5	MCL
2-Butanone	2000	(a)
Chloromethane	63	(b)
Chloroform	100	MCL
1,1-Dichloroethane	350	(c)
1,2-Dichloroethane	5	MCL
1,1-Dichloroethene	7	MCL
1,2-Dichloroethene	cis: 70 trans: 100	MCL MCL
Methylene chloride	5	pMCL
Tetrachloroethene	5	MCL
1,1,1-Trichloroethane	200	MCL
1,1,2-Trichloroethane	5	pMCL
Trichloroethene	5	MCL

*	Reference US EPA Record of Decision, Medley Farm Site, 1991.
MCL	Safe Drinking Water Act Maximum Contaminant Level (40 CFR Parts 141.61)
(a)	Remediation level derived from EPA's Reference Dose (RfD).
(b)	Remediation level represents a one-in-one-hundred thousand excess cancer risk, chloromethane is a Class C carcinogen.
(c)	Remediation level derived from EPA's Reference Dose (RfD) with an additional 10-fold safety factor. 1,1-dichloroethane is a Class C carcinogen.
pMCL	Proposed Maximum Contaminant Level (55 FR 30370)

To evaluate different recovery well placement scenarios, the US EPA's ground water capture zone modelling program, GPTRAC, will be used. GPTRAC is the general particle-tracking module of the Wellhead Protection Area (WHPA) series. Input parameters to this program include modelling area, ground water flow direction, hydraulic gradient, porosity, aquifer thickness, hydraulic conductivity, transmissivity, and type of hydraulic unit (i.e., confined or unconfined). Since data collected during Phase I and Phase II of the RI does not indicate significant variability in these parameters, the WHPA GPTRAC capture zone model is appropriate for this site.

Output from the capture zone modelling will be used to help design a ground water pumping system that will meet the following objectives:

- Minimize the potential threats posed to public health and the environment from current and potential migration of hazardous substances in the ground water at and from the site.
- Reduce concentrations of hazardous substances in ground water to remediation levels.
- Reduce the volume, toxicity, and mobility of hazardous substances at the site.

Performance monitoring of the ground water recovery system will be conducted to assess the effectiveness of the system. Data that will be collected along with the frequency with which that data is collected will be provided in the Performance Standards Verification Plan. This plan will be submitted with the RA Work Plan.

3.5 Treatability Studies

Treatability studies are anticipated to better define and evaluate possible technical issues such as metals precipitation, suspended solids removed, corrosion, and scaling. These studies will be conducted during the remedial design and will consist of the following:

- A series of bench-scale jar tests to identify physical and chemical conditions under which metals precipitation (primarily iron) occurs and steps to minimize this occurrence.
- Filtration testing to identify particle size distribution and mass loading rate from which a decision as to the need for filtration equipment will be made.
- Evaluate ground water chemistry to consider possibility of scale formation within the ground water extraction system.

Samples for these tests may be collected as a part of the quarterly site monitoring program or as a discrete sampling event. The data will be incorporated into the prefinal/final design submittal.

Section 4
REMEDIAL DESIGN ACTIVITIES

4.1 Design Objectives

The design objectives for the Medley Farm RD include the remedial action objectives described in Section 2.7 of this work plan and the following:

- Incorporate life-cycle cost design considerations into the design criteria for the treatment system to address the following:
  - Incorporate system flexibility to enable up-sizing or down-sizing treatment equipment in response to site requirements.
  - Keep treatment systems as reliable as possible to minimize O&M.
  - Minimize needs for operator oversight of system,
  - Reduce long-term chemical costs, wherever possible,
  - Select materials of construction appropriate for duration of remedial action.
- Construct necessary Site access and security measures.
- Install required utilities and erosion control measures.
- Develop a thorough understanding of site hydrogeologic conditions to make most efficient utilization of treatment system resources.
- Incorporate sufficient conservatism into air-stripper design to adequately strip the less volatile components.
- Examine and evaluate need for air quality control systems.
- Define and utilize possible indicator parameters during performance standards verification to minimize long-term analytical costs.
- Continually update remediation goals as more current technical information becomes available in such references as HEAST and IRIS.

4.2 Approach to Remedial Design

RMT's overall approach to the Medley Farm RD/RA is shown on Figure 4-1. This graphic depicts the various project design components, construction iterations, and general project work flow during both the design and implementation phases of this RD/RA project.

U.S. EPA REGION IV

SDMS

Unscannable Material Target Sheet

DocID: 10294320 Site ID: SCD980558142

Site Name: Medley Farms Box 4 of 13

Nature of Material:

Map:	✓	Computer Disks:	
Photos:		CD-ROM:	
Blueprints:		Oversized Report:	
Slides:		Log Book:	

Other (describe):

Amount of material: 1 Fig. 4-1 RMT APPROACH TO MEDLEY FARM SITE REMEDIAL DESIGN/REMEDIAL AC

Please contact the appropriate Records Center to view the material.

The design phase of the RD project initiates with the submittal of the Remedial Design Work Plan and culminates with the submittal of the Final Design Package to the US EPA. Approval of the Final Design submittal by US EPA represents the completion of the Remedial Design phase.

4.3 Design Elements

The proposed remedy for the Medley Farm Site consists of a source control remedy for affected vadose (unsaturated) zone soils and a ground water remedy for treatment of the ground water. The source control remedy will utilize soil vapor extraction (SVE) technology for in-situ removal of VOCs from the affected soils. This system will apply a negative pressure to unsaturated soils which will effectively remove volatile and some semi-volatile organic compounds from the soils. This step is taken to prevent or otherwise minimize further leaching of organic contaminants from the unsaturated soils to the ground water.

A system of jet pump extraction wells will be used to remove ground water from the underlying aquifer. Extracted ground water will be piped to a centrally-located ground water treatment system, where it will be processed through an air stripping unit and discharged to the surface water regime. The following elements constitute the primary design phases for this remedial design.

4.3.1 Design Criteria Report

The Design Criteria Report will detail the basis for design of all treatment equipment and related appurtenances to be utilized during the Remedial Action. Information and data collected during the Medley Farm RI/FS will be evaluated and used to develop these criteria. Applicable regulatory requirements will also be examined to determine possible limiting requirements. Specific design criteria will be developed for the following treatment system features:

- Access roads, utilities, and security systems.
- Recovery well systems that will be utilized by both SVE wells and jet pump extraction wells.
- Overall SVE system design features including specific well depths, well spacing intervals, pump sizing, system power requirements, and piping sizes/types.
- The overall jet pump ground water extraction system design including specific well depths, well spacing intervals, required pumping rates, pump sizes, power requirements, and pipe sizes/types.

- Storm drainage/erosion control design features including storm water collection and control, runoff curve numbers, maximum velocities, and specific site re-vegetation requirements.

- Options for addressing possible NPDES permitting requirements for storm water runoff.

- Air stripper design features including maximum flow rates, constituent concentrations, effluent limitations, and permit requirements.

- Emission control treatment system design features including discharge limitations and permit requirements, as required.

- Disposal and handling requirements for on-site generated wastes, sludges, drill cuttings, etc.

- Utility provision for construction, including power and water supplies.

4.3.2 Process and Instrumentation Diagram

Following preparation of the system design criteria, a process and instrumentation diagram (otherwise known as a P&ID) will be prepared to schematically identify the various treatment system components, control/monitoring equipment, and general process flow. The P&ID is the most basic project design drawing and is the first drawing developed to indicate the relationships between the various equipment and vessels. The P&ID will provide the basis for future development of system controls and balancing system interactions.

4.3.3 General Arrangement Drawing

A general arrangement drawing will be prepared in concert with the P&ID. The intent of this drawing is to communicate the approximate physical location of the RD/RA system relative to pertinent site features.

4.3.4 Process Narrative

The process narrative is next prepared by process engineers to communicate to the various design disciplines the precise intent and purpose of the remediation system. The process narrative will generally consist of a description of the treatment processes that will be in use during the remediation; a general discussion of the required equipment and appurtenances; a discussion of the SVE, jet pump systems, and air stripping systems; and how these various systems interact and inter-relate with each other.

4.3.5 Equipment List/Data Sheets

A detailed list of the required equipment, appurtenances and their associated data sheets will then be compiled. This information will ultimately be used to develop the technical specifications and design drawings for the treatment systems. Special or unusual items required for proper system interaction will be identified during this time as well as critical path fabrication or delivery schedules.

4.3.6 Engineering Design

Using the information developed during the previous elements, specific engineering design activities will begin. The initial design work will start off with the development of preliminary submittals to the US EPA and culminate with the submittal of the final design package. As defined by the Consent Decree and SOW, there will be no intermediate design submittal for this project.

The various design features include:

- Process engineering to establish the required unit operations, material balances, and flow rates.
- Civil engineering design of site clearing/grading plans; utilities; site security; general facility layout; access roads; underground piping; pump sizing; design and selection; jet pump selection; site drainage design; and erosion control measures. This will include the definition of any additional easements required by construction.
- Structural engineering design which will include necessary concrete foundation design work, equipment anchorage, and storage tanks.
- Mechanical engineering design to include air stripper and off-gas treatment system design (as required).
- Electrical engineering design which includes providing power supply to the various treatment units, pumping systems and other equipment controls.
- A value engineering review of the overall remedial design at key points during the process (reference Figure 4-1).

These detailed design plans will form a significant portion of the Prefinal/Final design submittal to the US EPA.

4.3.7 Technical Specifications

A set of project specifications will be developed to supplement the design drawings. Project specifications provide additional details regarding specific construction materials and procedures to be used during the project.

4.3.8 Construction Cost Estimates

Industry-accepted standards will be used to develop an opinion of the probable costs associated with the proposed construction activities. The design drawings and project specifications will be used to develop quantities. Unit prices for the cost estimate will be obtained from published and/or local sources of information.

4.3.9 Construction Schedule

A construction schedule will be developed based on standard construction practices. The construction schedule will indicate and reflect the staged development of the project implementation to ensure that each system is properly interfaced with related systems.

Section 5
REMEDIAL DESIGN PROJECT SCHEDULE

The project schedule for the Remedial Design is shown in Figure 5-1. This project schedule includes the additional field investigations slated for the Northeast section of the property; development of the applicable preliminary, prefinal, and final design documents; and preparation of the Operations and Maintenance Plan. This schedule will become an enforceable portion of the Medley Farm RD/RA Consent Decree upon receipt of the US EPA's written approval of this work plan.

U . S . E P A R E G I O N I V

SDMS

Unscannable Material Target Sheet

DocID: 4320 Site ID: SCD980558142

Site Name: Medley Farms Box 4 of 13

Nature of Material:

Map:	✓	Computer Disks:	
Photos:		CD-ROM:	
Blueprints:		Oversized Report:	
Slides:		Log Book:	

Other (describe):

Amount of material: 1 (Remedial Design Project Schedule)

Please contact the appropriate Records Center to view the material.

Section 6
REMEDIAL DESIGN DELIVERABLES

6.1 Preliminary Design Submittal

6.1.1 Additional Data Results

Additional data gathered during the project planning phase will be compiled, evaluated, summarized, and submitted to US EPA in the form of a Technical Memorandum. This letter report will indicate how the extent to which this information impacts the design criteria and ongoing remediation efforts.

6.1.2 Design Criteria Report

The Design Criteria Report will detail the basis for the design of all facilities at the site. Specific information to be included in this report will include:

- Waste characterization analyses
- Pretreatment requirements
- Preliminary Design assumptions
- Influent/effluent flow rates
- Influent/effluent water quality measurements/estimates
- Materials and equipment
- Performance standards
- Performance monitoring requirements

6.1.3 Preliminary Plans and Specifications

Preliminary drawings and sketches of the proposed remedial design system will be submitted along with an outline of the proposed technical specifications, including performance standards. RMT anticipates that this initial submittal will be conducted in conjunction with a project meeting to discuss and receive Agency comments.

6.1.4 Project Permitting Approach

A plan for satisfying applicable permitting requirements will be submitted to the Agency for review and comment. At present, RMT is evaluating the need for either NPDES surface water discharge permits and air quality permits. If required, this plan will identify the off-site disposal/discharge permits that are required, the time required to process the permit applications, and a schedule for submittal of the permit applications.

6.1.5 Draft Construction Schedule

A draft schedule for implementation of the remedial action will be submitted for the Agency's review and information. The schedule will identify RMT's best estimates of the required timing for initiation and completion of critical path tasks, specific dates for major project milestones, and specific tasks. This draft construction schedule will ***not*** become an enforceable part of the Consent Order until it is finalized during the Remedial Action Work Plan and approved by EPA. Therefore, this document's intended use is as a planning tool for the EPA, SC DHEC, and the Medley Farm Site Steering Committee.

6.1.6 Performance Standards Verification Plan

This plan will consist of the Performance Standards Verification Field Sampling and Analysis Plan and the Performance Standards Verification Quality Assurance/Quality Control Plan. The first document will provide guidance for all fieldwork by defining in detail the sampling and data gathering methods to be used on the project. The second document will describe the policy, organization, functional activities, and quality assurance and quality control protocols necessary to achieve the performance standards noted in the ROD and the Remedial Design plans and specifications. This document shall also incorporate the long-term remedy monitoring called for by the SOW.

6.2 Prefinal/Final Design Submittal(s)

6.2.1 Engineering Design Analyses

This document will include all required design calculations, design criteria, and an analysis documenting and supporting the selected design approach.

6.2.2 Plans and Specifications

A set of construction drawings and specifications which describe the selected design will be submitted to the Agency stamped "FOR INFORMATION ONLY", as a part of the Prefinal

Design submission. Following Agency review and incorporation of Agency comments, these final design submittals will stamped "ISSUED FOR CONSTRUCTION".

6.2.3 Construction Schedule

The draft schedule for implementation of the remedial action will be finalized to include possible expansions or reductions in the overall project scope and/or duration.

6.2.4 Construction Cost Estimate

An opinion of the probable costs for the construction of the remedial design will be prepared based on standard engineering practice.

6.2.5 Operations and Maintenance Manual

During the prefinal/final design, RMT will prepare an Operation and Maintenance Plan that will be submitted for Agency review and comment. This plan will include the following information:

- Equipment start-up and operator training data,
- Description of normal operations and maintenance activities,
- Description of potential operating problems,
- Description of routine monitoring and laboratory testing,
- Description of alternate Operations and Maintenance options,
- Facility Health and Safety plan,
- Description of equipment, and
- Required records and reports.

Section 7
REMEDIAL ACTION PLANNING

As indicated in Figure 4-1 and in accordance with the SOW, RMT will prepare the following documents concurrently with the preparation of the Prefinal/Final design submittal:

- Remedial Action Work Plan,
- Construction Management Plan,
- Construction Quality Assurance Plan,
- Construction Health and Safety/Contingency Plan, and
- Performance Standards Verification Plan.

7.1 Remedial Action Work Plan

RMT will prepare and submit a Work Plan describing the manner and approach in which the remedial action will be implemented. This Work Plan will include a comprehensive description of the work and a construction management schedule for completion of the major project work activities and deliverables.

7.2 Construction Management Plan

This document will be developed to indicate the manner in which construction activities will be implemented and coordinated with US EPA during the RA. The Construction Management Plan will identify key site representatives, project management personnel and applicable duties and responsibilities. This document will provide an overview of how construction activities, changes, and reviews will be conducted.

7.3 Construction Quality Assurance Plan

The Construction Quality Assurance Plan will be developed to ensure that the completed remedial action address the design criteria set forth. This document will be prepared in accordance with the requirements of the SOW.

7.4 Construction Health and Safety/Contingency Plan

The existing Remedial Design Health and Safety Plan will be reviewed to ensure that it addresses the specific needs of on-site construction workers and local affected populations. This document will be developed to address the requirements of the SOW.

7.5 Performance Standards Verification Plan

The Performance Standards Verification Plan will be developed to verify completion of the remedial objectives for the site. This document will be prepared in accordance with the SOW.

7.6 Remedial Action Report

This document will be developed within thirty days after the final construction inspection and will certify that all items in the Consent Decree, including the ROD, SOW, and all incorporated documents, have been completed and that the remedy is functional, operating, and has been constructed in accordance with the design plans and specifications. The report shall include the following:

- Brief description of how outstanding items noted in the Prefinal Inspection were resolved;
- Synopsis of the work defined in the SOW and certification that this work was performed;
- Explanation of modifications made during the RA to the original RD and RA Work Plans and why these changes were made;
- As-built and Record Drawings; and
- Documentation of how the O&M Manual and the Performance Standards Verification Plan are being implemented.

Section 8
PROJECT MANAGEMENT PLAN

8.1 Project Team

RMT organizes internal technical resource groups by department (e.g. civil engineering, hydrogeology, process engineering, mechanical engineering, electrical/instrumentation, etc.). However, we utilize a matrix management system to better address the specific needs and concerns of major projects that are complex and require a multi-disciplinary response. For projects like the Medley Farm RD/RA, we also utilize a more complex project management system capable of coordinating multiple resource departments and technical professionals towards the common goal of effectively and efficiently developing and implementing the remedial design.

During the Medley Farm Remedial Design, RMT will utilize both a Project Manager (PM) and a Project Coordinator (PC). RMT's Project Manager will be Mr. David Nichols. Mr. Nichols is a Vice President at RMT and will provide senior oversight of the project team and maintain overall responsibility for the project. He will also serve as a point of contact for US EPA and Medley Farm Site Steering Committee needs and concerns.

RMT's Project Coordinator will be Dr. Steve Webb, who is a Project Manager and Senior Project Engineer at RMT. Dr. Webb will be responsible to the Project Manager for technical, regulatory, and financial aspects of the project. In addition, the Project Coordinator will address routine project functions and activities. Dr. Webb will serve as the primary point of contact for SC DHEC, US EPA, and Medley Farm Site Steering Committee inquiries, needs or requests.

In addition to these individuals, RMT will assign specific Quality Assurance Reviewers and Technical/Regulatory Specialists to the Project Team based on the specific needs of the project. Each individual will have a background and experience commensurate with the required technical/regulatory duties. RMT's anticipated Project Team for the Medley Farm RD is shown in Figure 8-1.

8.2 Quality Management

At RMT, project management, quality assurance, and quality control are all integral parts of the project from the initial field work, through conceptual design, and on to final design deliverables. As technical specialists are appointed to the project task force from their respective resource department, these individuals utilize internal technical standards which are intended to guide their work and ensure that the necessary quality assurance/quality control procedures established for each design task are followed.

Quality Control is accomplished at the departmental level. Individual Department Managers are responsible for implementing RMT technical standards and ensuring that the prescribed quality control reviews are conducted. Quality Control also extends to editorial reviews by RMT's staff of technical editors and on into report production and graphics.

The Project Manager and the Project Coordinator play a key role in the QA/QC process at RMT. Their role in QA/QC is multi-faceted and vital to the overall success of the project. The PM/PC serves as RMT's front-line technical and regulatory representative to both the Medley Farm Site Steering Committee, US EPA, and SC DHEC. From this key position, the PM/PC are responsible to ensure that both QA and QC considerations are addressed. RMT's PM/PC are responsible for ensuring that a QA/QC Plan is filled out for all projects prior to their initiation (reference Figure 8-2). The QA/QC Plan is prepared and circulated to all assigned staff.

RMT's QA reviewers are selected from experienced senior design/regulatory professionals who are knowledgeable with all aspects of the required project tasks. QA reviewers are knowledgeable of the project tasks, but are unrelated to the overall project team. In this manner, QA reviewers are able to provide the necessary checks and balances and a third party perspective that is essential if the final work product is to be of a uniform level of quality and consistency.

The QA reviewers for the Medley Farm Remedial Design are identified on Figure 8-1. These individuals include Mr. Jim Marler (Design Services), Dr. Jim Clemmer (Process Design), and Mr. Ian Hart (Hydrogeology). Each of these individuals has special talents and skills which will capably support project needs.

8.3 Monthly Reporting

RMT's Project Coordinator will be responsible for ensuring that monthly project reports ar prepared and submitted to the US EPA's Project Manager for review and information. These reports will be initiated

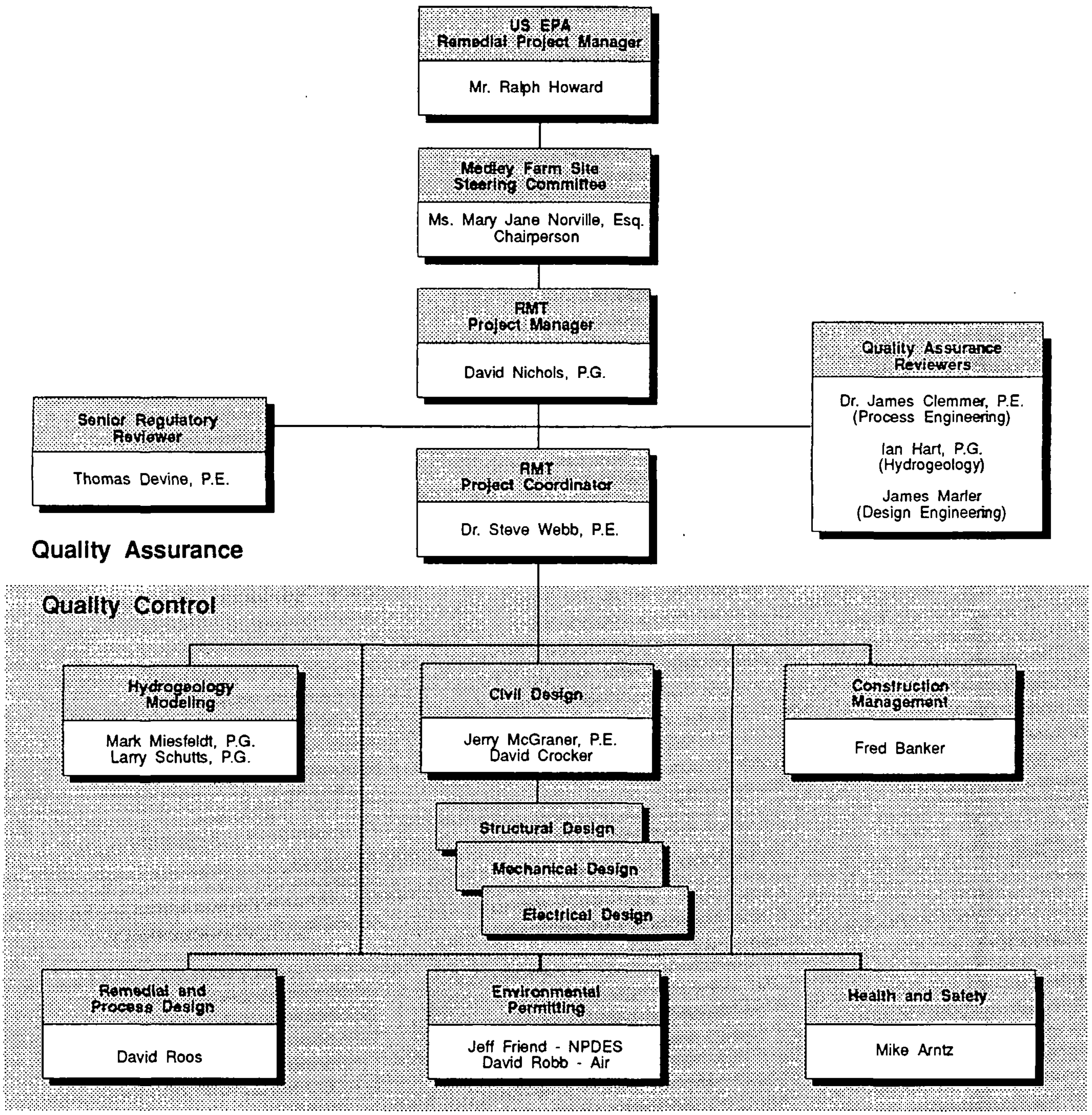


Figure 8-1

Medley Farm NPL Site RD/RA
Organization Chart

on or before the 1st of each month and submitted to select Medley Farm Site Steering Committee reviewers. Monthly reports will be submitted to the US EPA's Project Manager by the 10th of each month in accordance with the requirements of the Medley Farm RD/RA Consent Decree.

8.4 Meetings

All project meetings will be jointly agreed upon and coordinated by the US EPA, the Medley Farm Site Steering Committee, SC DHEC and RMT. Due to the nature of this project, we anticipate that the majority of the review and comment process will be conducted by mail. However, in cases where a meeting is deemed appropriate, the US EPA is requested to coordinate such requests directly through either the Chairperson of the Medley Farm Site Steering Committee or the RMT PM/PC.

RMT

QUALITY ASSURANCE
QUALITY CONTROL PLAN

PROPOSAL FOR:
PROJECT NAME:

MIF NO:
PIF NO:

First Prepared:
Prepared By:

Revision No:
Reviewed By:

Proposal (Incl. Scope):

Client Contract:

Work Plan:

Budgets:

Health & Safety Plan:

Schedule:

Issues & Concept Review

QA:

Senior Consultants: ________ ________ ________

Senior Technical: ________ ________ ________ ________ ________ ________

Meeting Frequency (1 Mandatory):

Findings & Conclusion Review

QA:

Senior Consultants: ________ ________ ________

Senior Technical: ________ ________ ________ ________ ________ ________

Meeting Frequency (1 Mandatory):

Progress Reviews

QA:

Senior Consultant: ________ ________

Project Team: ________ ________ ________ ________ ________ ________

Meeting Frequency: (3 Minimum):

Subcontracts	Lead	Preparation QA/QC	Performance QA/QC
1.			
2.			
3.			

Distribution: Assigned Staff
PM/Proj. File
QA Officer

Page (1)

Figure 8-2
Project QA/QC Plan

QUALITY ASSURANCE / QUALITY CONTROL PLAN

Calculations	Lead	QC	QA
Type -			
Type -			
Type -			
Type -			

Report	Writer	Lead Writer	Senior Reviewer	Seal*	QA
Section -					
Section -					
Section -					
Section -					
Graphics					

Overview Technical Editor:

Production Word Processor: Report Coordinator:

* Check if PE ___, PG ___, CIH ___, Other ___ Registration required for State of_______________.

Opinion of Probable Cost	Estimator	QC	QA

Drawings	Design	QC	Seal*	QA
Type -				
Type -				
Type -				
Type -				

* Check if PE ___, PG ___, CIH ___, Other ___ Registration required for State of_______________.

Specifications/Project Manual	Writer	QC	Seal*	QA
Division -				
Division -				
Division -				
Division -				
Division -				

Production Word Processor: Report Coordinator:

* Check if PE ___, PG ___, CIH ___, Other ___ Registration required for State of_______________.

Construction Contract	Preparation QC/QA	Performance QC
1.		
2.		

Page (2)

Figure 8-2
Project QA/QC Plan

Section 9
DATA MANAGEMENT PLAN

Procedures for data management have been established to document and track project analytical data, design drawings, and computer files as they are generated, reviewed, and issued for construction. These procedures are described in the following sections.

9.1 Analytical Database Management

Analytical data generated by the CLP laboratory will be transferred into a database file whose format is compatible with FoxPro and dBase III software. The CLP laboratory will perform a QC check on the data maintained in these files. At a minimum, the file format will have a field for sample name, sampling date, and the CLP TAL and TCL analytes. Other fields will be added to the database for other analytes and/or other data types, as deemed appropriate.

Concentrations of the TAL/TCL analytes will be entered into the database in parts per million (ppm). These files will be transferred from the CLP laboratory to RMT's regional offices by overnight delivery of floppy diskette or by electronic downloading across RMT's computer network. The data files will then be placed into project specific subdirectories on RMT's computer network where authorized personnel can then retrieve and access the data.

9.1.1 Data Tabulation

A FoxPro database system will be used to access and maintain the analytical database. Data will be transferred from FoxPro to Lotus 1-2-3 to create data summary data tables or to calculate statistical values. Data will be summarized in tables which are sorted by sample media and analyte fraction (i.e., volatile organics, semivolatile organics, pesticides/PCBs, or inorganics). Analytes will be sorted alphabetically within each fraction. In order to maintain concise summary tables, analytes which are not detected in any sample of a given media will not be included in the summary table for that media. Table 9-1 is an example of the data summary table format.

TABLE 9-1
TYPICAL DATA SUMMARY TABLE
MEDLEY FARM SITE

PARAMETER [1]	SAMPLE					
	MW03	MF03	MW04	MF04	MW04A	MF04A
Acetone	ND		ND		ND	
Chloroform	ND		ND		ND	
1,2-Dichloroethane	ND		0.005		ND	
1,2-Dichloroethene (total)	ND		ND		ND	
1,2-Dichloropropane	ND		0.014		ND	
Methylene Chloride	ND		ND		ND	
1,1,1-Trichloroethane	ND		ND		ND	
Xylenes (total)	ND		ND		ND	
bis(2-Ethylhexyl)phthalate	ND		ND		ND	
Aluminum	12.5	ND	40.9	ND	6.21	ND
Barium	ND	ND	0.376	ND	ND	ND
Calcium	ND	ND	16.3	16.1	ND	ND
Cobalt	ND	ND	0.065	0.051	ND	ND
Copper	ND	ND	ND	ND	ND	ND
Iron	16.2	ND	32.7	ND	5.64	ND
Lead	0.005	ND	0.017	ND	ND	ND
Magnesium	ND	ND	15.3	8.57	ND	ND
Manganese	0.275	ND	3.25	2.91	0.154	0.023
Nickel	ND	ND	0.134	0.147	ND	ND
Potassium	ND	ND	12.6	ND	ND	ND
Sodium	ND	ND	344	360	12.6	12.4
Vanadium	0.051	ND	0.115	ND	ND	ND
Zinc	0.037	ND	0.080	ND	0.035	ND
Alkalinity [2]	ND		410		40	
Chloride	3.9		390		4.7	
Sulfate	ND		68		ND	
Total Suspended Solids	220		620		250	

B Analyte detected in analytical method blank.
N Spiked sample recovery recovery not within control limits.
* Duplicate analysis not within control limits.
░ Analyte above the drinking water MCL.

CLP Form Is and CLP data package narratives will be sent to EPA under a letter of transmittal. Data summary tables will be included with these major reports and sent to EPA for ease of review.

9.1.2 Data Visualization

Data may also be exported from FoxPro to graphics software (e.g., Lotus Freelance) to create time versus concentration plots of constituents detected at individual sampling points such as monitoring wells or a soil vapor extraction system. This capability will be helpful in assessing the effectiveness of remedial activities. Figure 9-1 is an example of a time versus concentration plot created using this approach.

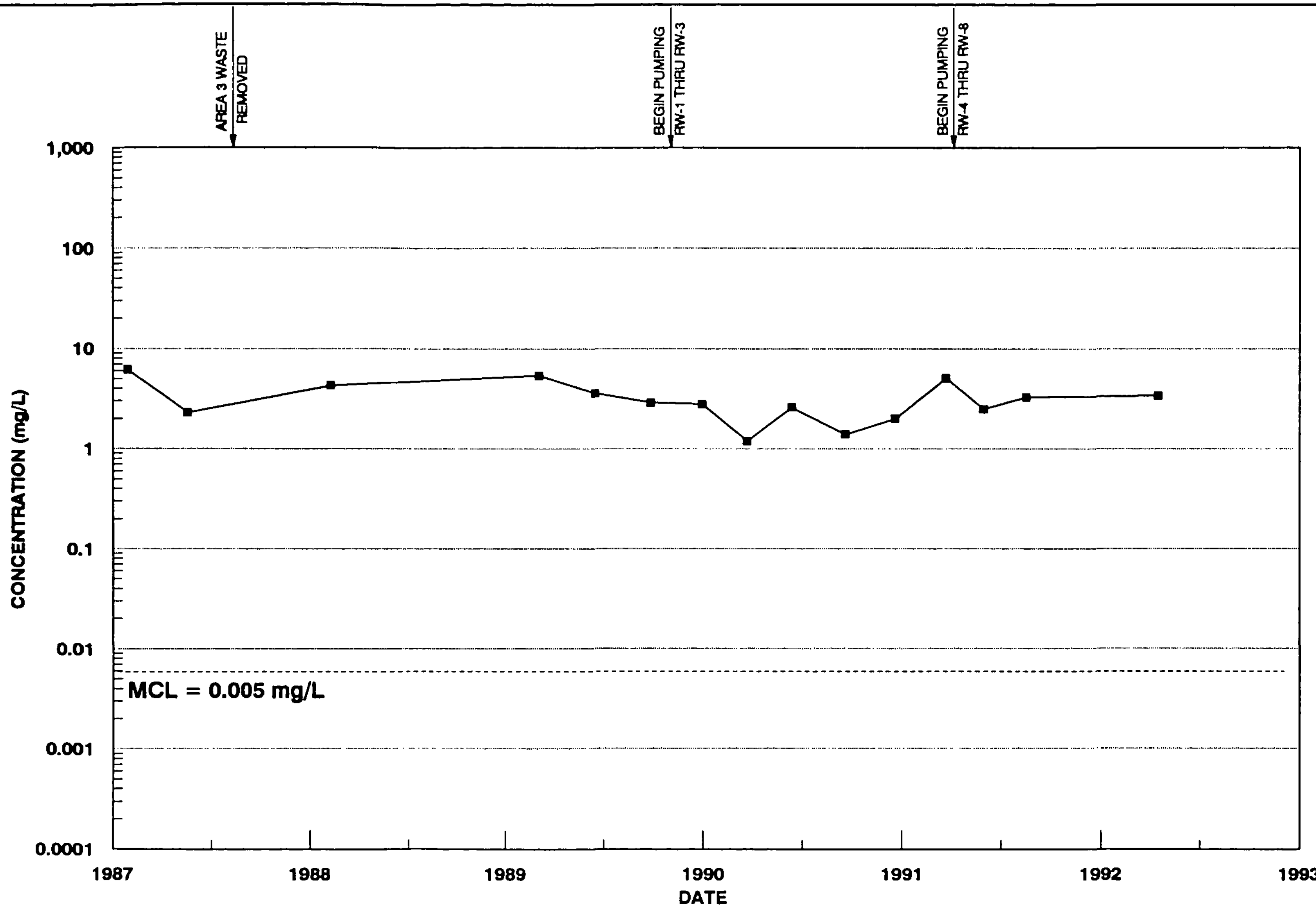
An Intergraph WorkStation can also be linked to the database files to post analytical data on a site map (e.g., ground water data beside monitoring well locations). Data concentration maps may be generated, if appropriate, to visualize the extent of subsurface releases. Analyte concentrations may be contoured on the site map.

9.2 Document Control

Data and documents originating in the field (e.g., Chain-of-Custody documents; overnight carrier shipping records; field notes; and field generated data) will be placed in a project file. Chemical data reports sent from an analytical laboratory will be received by the Laboratory Coordinator. The Laboratory Coordinator will be responsible for storing the reports in a secure location and maintaining a Data Report Tracking Log. This log will document the placement of the data reports into the secure location and subsequent removal/replacement of reports from/to the storage area.

Communications with the analytical laboratory (e.g., work orders, sample acknowledgement forms, and memos documenting laboratory actions/problems/resolutions) will be placed into the project file. Comments from the review/validation of CLP data packages will be stored in the project file. These notes will include:

- Non-conformance of data packages to CLP protocols;
- Documentation of qualifiers added to laboratory data by the QA/QC reviewer(s) which render data questionable or unusable;



MW-21 1,1-DICHLOROETHYLENE VS TIME

FIGURE 9-1

- Documentation of detections assessed to be false positives because of improper analytical procedures or the presence of compounds in blanks;

- Documentation of how data qualifiers originating during the data review/verification process will be distinguished from laboratory data qualifiers on an electronic database and in data summary tables.

9.3 Design File Management

All design drawing files will be generated for Intergraph Microstation 4.0 (or most current version). Design files will be stored on a networked hard drive in a directory named in accordance with the associated discipline and RMT project number. The files are backed up daily by the network manager. Files may be moved to tape or diskette storage, as required.

When a project is closed, the project manager initiates archival of hardcopy reports, design drawings and files, and project related computer files (including database files).

Section 10
COMMUNITY RELATIONS

The involvement of RMT and the Medley Farm Site Steering Committee in providing Community Relations support will be limited to providing the US EPA with information requests and preparing periodic newsletters for distribution to area residents as project needs dictate. The primary responsibility for Community Relations at this project will be addressed by the US EPA Project Manager and Community Relations Coordinator.

U . S .   E P A   R E G I O N   I V

SDMS

Unscannable Material Target Sheet

DocID: 10294280 Site ID: SCD980558142

Site Name: Medley Farms Box 4 of 13

Nature of Material:

Map:	✓	Computer Disks:	
Photos:		CD-ROM:	
Blueprints:		Oversized Report:	
Slides:		Log Book:	

Other (describe):

Amount of material: 6 (Medley Farms Gaffney, S.C.)

Please contact the appropriate Records Center to view the material.

RMT, Inc.
100 Verdae Blvd.
P.O. Box 16778
Greenville, SC 29606
Phone: 803-281-0030
FAX: 803-281-0288

March 6, 1992

Mr. Ralph O. Howard, Jr.
Remedial Project Manager
US EPA, Region IV
345 Courtland Street
Atlanta, Georgia 30365

Subject: Technical Memorandum Regarding Treatability Study Work Plan for the Medley Farm NPL Site; Gaffney (Cherokee County), South Carolina.

Dear Ralph:

In accordance with the requirements of the Medley Farm RD/RA Consent Decree (CD) and Scope of Work (SOW), RMT is pleased to submit this technical memorandum addressing the issue of Treatability Studies during the Medley Farm RD/RA. In the following pages, we present a discussion and technical justification in support of our position that formal Treatability Studies are not required prior to the design of SVE and air-stripping systems required for the Medley Farm RD/RA. Treatability tests are planned during several engineering and construction-related tasks during the RD/RA, but the description of these studies are better dealt with in the text of the RD and RA Work Plans.

EXECUTIVE SUMMARY

The specific remediation technologies stipulated by the Medley Farm Site Record of Decision (ROD) and SOW, soil vacuum extraction (SVE) and air stripping, are well-documented technologies that have been successfully applied at sites in a wide diversity of geologic settings. During the past several years, RMT has accumulated extensive experience in utilizing both SVE and air-stripping within the Piedmont region of South Carolina for remediation of VOC-affected vadose zone soils and ground water. Much of this regional experience has been acquired in geologic settings nearly identical to that observed at the Medley Farm Site.

Our knowledge and application of SVE and air-stripping systems has progressed to a point where it is no longer a question of whether these systems will be effective and implementable in the Piedmont region, rather what site-specific variables need to be addressed to enhance the overall performance of the system. For the Medley Farm Site, we envision an approach to the Remedial Design/Remedial Action (RD/RA) that relies more on actual field performance data and less on bench/pilot-scale field studies. For this reason, we propose to conduct only system-specific treatability testing as a part of the actual RD/RA. This approach does not require the development of a Treatability Study Work Plan, because we can readily incorporate the required test procedures into either the Remedial Design Work Plan or the Remedial Action Work Plan. A discussion of our overall approach follows:

Upon review of the specific ROD-designated SVE sites, the relative concentrations of the volatile organic compounds (VOCs) observed in both soils and ground water, and the specific Constituents of Concern (COCs) involved, we became convinced that formal Treatability Studies assessing the adequacy of SVE and air-stripping for removal of VOCs from these site soils and ground water were not required to achieve the remedial objectives outlined by the ROD. While the geology and hydrogeology of the Piedmont is heterogenous and complicated, our prior experience in

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conducting SVE and air-stripping operations within this region has demonstrated that extensive Treatability Studies often provide no better basis for design than empirical knowledge and experience already at our disposal.

We have learned that the variables associated with the geology and hydrogeology of the Piedmont are so numerous that it raises the question of the cost-effectiveness of Treatability Studies when site conditions may vary significantly across only a short distance. To address these uncertainties, RMT has developed a unique approach to remediation of VOC-affected soils and ground water in the Piedmont that utilizes technology that has proven its effectiveness during numerous site remediations, is easy to install, simple to operate and sufficiently flexible in its design to accommodate field changes and modifications observed over time. A general discussion of this remedial approach is presented in Attachments A and B for your review and consideration.

We have previously conducted SVE and air-stripping Treatability Studies within the Piedmont region, but we now believe that it to be more effective and timely, from a technical and cost standpoint, to proceed directly with the overall site design and remediation, using the data and findings of the Medley Farm RI/FS, the field investigations described in our March 1992 Field Sampling and Analysis Plan (FSAP), and specific test procedures that would be used during the RD and RA. We have found that SVE and air-stripping systems are simple, straight-forward remedial technologies that can be designed such that they are amenable to system enhancement subsequent to start-up and continued field operation. The remedial system envisioned for the Medley Farm Site (described in Attachment A) would be similarly designed and constructed using cost-effective materials (such as PVC) that would easily facilitate periodic adjustments or modifications to the system, should the need be identified. The key to a successful remediation project is to develop a design that is operationally simple and sufficiently flexible to respond to changing site conditions.

While we believe that formal Treatability Studies for the SVE and air-stripping systems are not required, we recognize that specific field testing is needed during the RD/RA process in support of the development of the overall design basis for the project. For instance, as SVE wells are being installed during the Remedial Action phase, a series of **In-situ** vacuum tests would be conducted by the SVE contractor to confirm the site-specific soil permeability and verify the well spacing interval called for in the design. RMT's design basis for spacing wells in the Piedmont region is conservative (30-40 feet on center) and based upon our prior experience. These **In-situ** tests would be conducted with the possible goal of justifying the overall number of soil vapor extraction wells and thereby minimize project costs.

Similarly, air-stripping VOCs from ground water involves evaluating a number of basic water quality considerations in anticipation of possible long- and short-term operational difficulties. The VOCs observed at the Medley Farm Site (Table 1) have been successfully remediated at a number of sites across the country and there is an adequate base of information upon which to develop the design for the air-stripping system. However, during the Remedial Design phase of the project, we expect to collect additional surface and ground water quality samples that would be analyzed in support of the overall system design. This additional site sampling would occur during one or more of the quarterly sampling events and would be designed to address the following key RD/RA considerations:

TABLE 1

HENRY'S CONSTANTS[a] FOR VOLATILE ORGANIC COMPOUNDS EXCEEDING REMEDIATION LEVELS IN GROUND WATER AT THE MEDLEY FARM SITE

Compound	Maximum Ground Water Concentration Observed at Medley Farm Site $\frac{\mu g}{L}$	Henry's Constant[a] @25°C $\frac{atm\ M^3}{moles}$	Henry's Constant[b] @25°C $\frac{atm\ M^3}{moles}$	Henry's Constant[c] @25°C $\frac{atm\ M^3}{moles}$	Henry's Constant[d] @25°C $\frac{atm\ M^3}{moles}$	Henry's Constant[e] @20°C $\frac{atm\ M^3}{moles}$	Potential Remediation Level[f] $\frac{\mu g}{L}$
Benzene	11	5.566×10^{-3}	5.59×10^{-3}	5.50×10^{-3}	-	4.6×10^{-3}	5
1,2-Dichloroethane	290	1.178×10^{-3}	0.98×10^{-3}	-	-	1.1×10^{-3}	5
1,1-Dichloroethene	2,200	2.286×10^{-2}	3.40×10^{-2}	-	-	$17. \times 10^{-2}$	7
Dichloromethane (Methylene Chloride)	110	2.476×10^{-3}	2.03×10^{-3}	3.19×10^{-3}	2.85×10^{-3}	2.5×10^{-3}	5[g]
Tetrachloroethene	200	2.685×10^{-2}	2.59×10^{-2}	2.90×10^{-2}	1.74×10^{-2}	2.3×10^{-2}	5
1,1,1-Trichloroethane	3,400	-	1.44×10^{-2}	3.00×10^{-2}	1.68×10^{-2}	3.6×10^{-3}	200
1,1,2-Trichloroethane	18	9.607×10^{-4}	11.7×10^{-4}	7.42×10^{-4}	-	7.8×10^{-4}	5[g]
Trichloroethene	720	1.167×10^{-2}	0.91×10^{-2}	0.91×10^{-2}	1.01×10^{-2}	1.0×10^{-2}	5

a Yaws, C.A., H-C. Yang, and X. Pan, "Henry's Constants for 362 Organic Compounds in Water," Chemical Engineering, Volume 98(11), p.179 (1991)

b US EPA, Superfund Public Health Evaluation Manual, EPA/540/1-86/060, p. 121 (1986).

c South Carolina Department of Health and Environmental Control, Air Pollution Control Database.

d Gossett, J.M. *et al*, Mass Transfer Coefficients and Henry's Constants for Packed-Tower Air Stripping of Volatile Organics: Measurement and Correlations, Air Force Engineering an Services Center, ESL-TR-85-18, 1985.

e Gross, R.L., Development of Packed-Tower Air Strippers for Trichloroethylene Removal Wurtsmith Air Force Base, Michigan, Air Force Engineering an Services Center, ESL-TR-85-28, 1985.

f All MCLs or Proposed MCLs

g Proposed MCL

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(1) Is there a specific need for metals removal from the treated ground water prior to discharge into either Jones Creek or its unnamed tributary ?

(2) What potential issues might be involved in obtaining a NPDES permit for discharge of treated ground water into a receiving stream with a likely 7Q10 of zero ?

(3) What is the corrosion or scaling potential of the extracted ground water ?

(4) What potential is there for inorganics precipitation or biological "sliming" within the air-stripping packing media ?

(5) Are air emission control systems required for either the SVE or air-stripping systems ?

To address these issues, we propose additional sampling of monitoring wells SW-1, SW-3, SW-4 and BW-2 and surface water monitoring stations within Jones Creek and its unnamed tributary. This sampling activity would be described more fully in the Remedial Design Work Plan. The following analytical parameters would be evaluated during this sampling event: total and dissolved iron, total and dissolved manganese, total and dissolved aluminum, calcium hardness, total hardness, pH, temperature, alkalinity (P and T), priority pollutant metals (NPDES permitting considerations), stream flow, and suspended solids.

These treatability tests are addressed in the SOW and will serve an important function in the design, but they do not warrant the development of a separate Treatability Study Workplan. The results of these studies will play a significant role in confirming the overall implementability of the selected remedy. In the following sections, we offer a more detailed technical discussion of our rationale why formal Treatability Studies are not required for the SVE and air-stripping systems.

TECHNICAL DISCUSSION REGARDING SOIL VACUUM EXTRACTION

A review of EPA's "Guide for Conducting Treatability Studies Under CERCLA" indicates that the Agency requires Treatability Studies at those CERCLA sites where it is necessary to verify the effectiveness and permanence of the selected remedy. The Medley Farm SOW expands on this point by requiring that Treatability Studies be conducted, as necessary, to evaluate whether the selected remedy will comply with all applicable or relevant and appropriate requirements (ARARs), attain all performance standards and achieve all other treatment requirements outlined in the ROD.

The ROD establishes risk-based treatment standards for the ground water that are listed in Table 2. However, risk-based treatment standards have not been developed for the soils and are not applicable, since neither direct dermal absorption from contact with the affected soils nor ingestion of the soils adds a significant level of risk to the future residential-use scenario. Specifically, the ROD provides the following discussion:

> **For the future on-site residential use scenario, ... [v]irtually all of the [carcinogenic] risk is from ingestion of ground[ ]water containing 1,1-dichloroethylene. The risk level from direct contact with soil ... for soil ingestion**

TABLE 2

CONCENTRATIONS OF VOLATILE ORGANIC COMPOUNDS IN GROUND WATER AT THE MEDLEY FARM SITE AND POTENTIAL REMEDIATION LEVELS [ROD, P.79]

Compound	Maximum Ground Water Concentration Observed at Medley Farm Site $\frac{\mu g}{L}$	Well	Potential Remediation Level $\frac{\mu g}{L}$	Source
Acetone	18	BW-2	350	(1)
Benzene	11	BW-105	5	MCL
2-Butanone	13	BW-106	2,000	(1)
Chloromethane	26	BW-108	63	(2)
Chloroform	10	BW-2	100	MCL
1,1-Dichloroethane	120	SW-4	350	(3)
1,2-Dichloroethane	290	BW-2	5	MCL
1,1-Dichloroethene	2,200	SW-4	7	MCL
1,2-Dichloroethene	31	SW-4	70[a] 100[b]	MCL
Dichloromethane (Methylene Chloride)	110	BW-2	5	MCL (Proposed)
Tetrachloroethene	200	SW-3	5	MCL
1,1,1-Trichloroethane	3,400	SW-4	200	MCL
1,1,2-Trichloroethane	18	BW-7	5	MCL (Proposed)
Trichloroethene	720	BW-2	5	MCL

(1) Derived from EPA's Reference Dose (RfD)
(2) Represents one in 10^6 excess cancer risk. Chloromethane is classified as a Class C carcinogen.
(3) Derived from EPA's Reference Dose (RfD) with an additional ten-fold safety factor. 1,1-Dichloroethane is classified as a Class C carcinogen.
a *Cis-* isomer
b *Trans-* isomer

... and for dermal absorption of chemicals in soil ... are within remediation level goals of 10^{-4} to 10^{-6}. These risk levels are mainly the result the presence of PCBs in the soils. ... Ingestion of ground[ ]water containing 1,1-dichloroethlyene is responsible for virtually all of the non-carcinogenic hazard. Hazard indices for soil ingestion ... and dermal contact with soil ... are both less than one, indicating that there is no concern for potential health effects from direct contact with residual on-site soil contamination. [Medley Farm ROD, page 64]

The soil remediation levels presented on Table 18 (page 76) of the ROD are not risk-based and were calculated for the site-specific VOCs using an organic leaching model that was not specifically identified. These calculated soil VOC concentrations, presented in Table 18 as "Potential Volatile Organic Soil Remediation Levels", were developed to using site-specific physical data and environmental fate considerations. The potential soil remediation levels calculated in Table 18 (also shown in Table 3) were intended to be protective of site ground water from possible leaching phenomena as evidenced by the following excerpt from the ROD:

Source areas with chemical levels exceeding calculated levels that are protective of the ground [ ]water would be remediated through soil vapor extraction (SVE). These calculated subsurface soil levels [Table 3] are based on a compound's potential to impact ground[ ]water above promulgated standards. A leach model incorporating site-specific physical properties and environmental fate considerations [was] used. [Medley Farm ROD, p. 74]

As depicted in Figure 23 of the ROD (page 75) and in Table 3, there are three specific areas of the Medley Farm Site that have been identified as requiring soil vacuum extraction:

Soil Remediation Area	Description
RA-1	A rectangular area approximately 75 feet by 120 feet. Test Pit No. 4 (TP-4) and Soil Boring No. 9 (SB-9) are located within this area.
RA-2	A square area approximately 75 feet by 75 feet. Test Pit No. 3 (TP-3) and Soil Boring No. 3 (SB-3) are located within this area.
RA-3	An "L" shaped area approximately 100 feet by 150 feet. Test Pit No. 12 (TP-12) and Soil Boring No. 4 (SB-4) are located within this area.

Remedial Areas RA-1 and RA-2

These two areas of the site are separated by only about 25 feet. The VOCs that are present above the ROD-prescribed remediation levels are tetrachloroethene, trichloroethene, 1,2-dichloroethene, 1,2-dichloroethane, and methylene chloride. Because of their small size and close proximity to one another, we believe that a single SVE system would be sufficient to

TABLE 3

POTENTIAL SOIL REMEDIATION LEVELS FOR VOCs [ROD, P. 18]

Compound	Soil Remediation Level $\frac{\mu g}{kg}$	Locations Where Remediation Level Exceeded $\frac{\mu g}{kg}$	Maximum Ground Water Concentration Observed at Medley Farm Site $\frac{\mu g}{L}$	Well	Potential Remediation Level[d] $\frac{\mu g}{L}$
RA-1					
1,2-Dichloroethane	60	SB-9 99 @ 25'-27'	290	BW-2	5
Dichloromethane (Methylene Chloride)	40	TP-4 110	110	BW-2	5[e]
Tetrachloroethene	1,600	TP-4 5,400	200	SW-3	5
Trichloroethene	500	TP-4 6,600	720	BW-2	5
RA-2					
Trichloroethene	500	TP-3 12,000	720	BW-2	5
Tetrachloroethene	1,600	TP-3 61,000	200	SW-3	5
1,2-Dichloroethene	2,100 (Total)	TP-3 12,000	31	SW-4	70[a] 100[b]
Dichloromethane (Methylene Chloride)	40	SB-3[c] 50 @ 10'-12'	110	BW-2	5[e]
RA-3					
1,2-Dichloroethane	60	TP-12 90 SB-4 3,700 @ 10'-12' 4,500 @ 15'-17' 680 @ 25'-27'	290	BW-2	5

(1) Derived from EPA's Reference Dose (RfD)
(2) Represents one in 10^6 excess cancer risk. Chloromethane is classified as a Class C carcinogen.
(3) Derived from EPA's Reference Dose (RfD) with an additional ten-fold safety factor. 1,1-Dichloroethane is classified as a Class C carcinogen.
a *Cis-* isomer
b *Trans-* isomer
c Location considered minimal risk to ground water based on site specific conditions. [ROD, p.76]
d All MCLs or Proposed MCLs
e Proposed MCLs

address both areas RA-1 and RA-2. The size of these areas and the relative concentrations of VOCs observed leads us to conclude that SVE would be very effective at these locations and that a formal Treatability Study is not required to evaluate whether SVE will achieve the stated remedial objectives.

According to the EPA's Soil Vapor Extraction Technology Reference Handbook (Pederson and Curtis, EPA/540/2-91-003, p.56-58), the primary design variable for soil vacuum extraction systems is the radius of influence of the extraction wells. The specific radius of influence for a given extraction well will vary from site to site, but typically, it ranges from 15 feet to 100 feet. Generally, sandy soils yield smaller influence radii than do more clayey soils and, for that reason, require more closely spaced extraction wells for a given air flow rate. As a rule of thumb, soil vapor extraction wells should generally be spaced no further apart than twice the depth to which they are installed (e.g., if the wells are 40 feet deep, they should be spaced no further apart than 80 feet on center). From the analytical results taken at SB-9, the SVE wells in Remedial Areas RA-1 and RA-2 would need to be at least 30 feet deep. Therefore, using EPA's rule of thumb, the SVE wells would need to be spaced at intervals of no more than 60 feet on center.

Krishnayya, *et al* (Proceedings of the Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water: Prevention, Detection, and Restoration, National Water Well Association, page 547, 1988) reported that soil permeability, soil moisture content, applied suction head, depth of the well, and presence of an impermeable seal at the surface most affected the radius of influence of vacuum extraction wells. Based on RMT's experience with soil vacuum extraction systems in the Piedmont Region of South Carolina (Attachment B), the area of influence for these types of vacuum extraction wells is generally between 30 and 60 feet. The SVE wells discussed in Attachment B were conservatively spaced on 40-foot centers in areas where the unsaturated soil thickness varied between 3 and 13 feet.

During the Medley Farm RA, it is likely that the SVE contractor would conduct in-situ testing within RA-1 and RA-2 to evaluate the site-specific soil permeability and confirm the desired spacing of the SVE wells prior to installation of the SVE wells. For this reason, we believe it would be most cost effective to design the SVE system in this area of the site using RMT's empirical knowledge and experience of SVE system performance in the Piedmont region (SVE wells installed on 30-40 foot centers), confirm the design basis during the RA using the in-situ field tests and finalize the number and location of the SVE wells based on these field measurements.

During the operational life of the SVE system, it would be possible to sample the affected soils and assess SVE system performance. In this manner, RMT can evaluate the performance of the system and address the need for possible system modifications. Using a 30-40 foot spacing interval for the SVE wells, we estimate that 15-20 SVE wells would be needed to adequately cover areas RA-1 and RA-2. The precise number of wells and required spacing interval would be established at the time the in-place measurements are taken.

Remedial Area RA-3

RA-3 is an "L" shaped area approximately 100 feet by 150 feet having a total area of approximately 13,500 ft^2. Since RA-3 is located only about 100 feet from RA-2, it could reasonably be included as a part of the SVE system used for RA-1 and RA-2. The only VOC detected above the ROD-prescribed remediation levels was 1,2-dichloroethane in TP-12 and SB-4 (Table 3). As previously stated, the size of this area and the low concentration of VOCs leads us to believe that SVE will be very effective in removing residual VOCs from the soils, but that a Treatability Study is not needed to confirm the effectiveness of the process.

As in the case of areas RA-1 and RA-2, it is likely that **in-situ** testing of the soils will be necessary to evaluate site-specific soil permeability and confirm the wells spacings for the SVE wells. For this reason, we recommend that the system design for this area be based on the 30-40 foot spacing interval. The design basis would be confirmed during the RA using the **in-situ** field tests at which time the final number and location of SVE wells could be established. For SVE wells spaced on 30- 40 foot centers, approximately 15-20 SVE wells would be required to cover RA-3.

TECHNICAL DISCUSSION REGARDING AIR STRIPPING OF GROUND WATER

Air stripping is probably the most commonly applied technology for treating volatile organic compounds present in ground water. The principal parameter required to design an air stripper for remediation of the ground water at the Medley Farm Site and to evaluate the feasibility of achieving the proposed remedial target levels is an equilibrium constant. The theoretical considerations for design of an air-stripping system are presented in Attachment C.

For dilute solutions of VOCs in water, Henry's Constant has been found to be useful in describing equilibrium conditions. Table 1 contains the Henry's Constants for the primary VOCs observed at the Medley Farm Site. This table also indicates the broad base of data available in the literature for design purposes.

RMT has successfully operated a number of air stripping units across the country and within the Piedmont Region of South Carolina. There are a number of typical engineering difficulties that are often encountered during these projects such as corrosion, carbonate scaling, accumulation of biological "slimes" on packing media and precipitation of inorganics within the air stripper. For these reaseons, we believe it to be prudent to carefully evaluate the potential for these types of concerns during the RD. These are specific treatability tests that are addressed by the SOW, but they are best dealt with in the context of the RD Workplan.

As we indicated during the RD/RA negotiations, we remain concerned by the potential problems associated with obtaining a NPDES permit for discharge of treated ground water to either Jones Creek or its unnamed tributary. The unnamed tributary to Jones Creek is a small creek with what we would presume to be zero flow during low flow conditions (7Q10=0). Based upon our past experience with projects of this type, NPDES discharge limitations for inorganics (including such parameters as copper and zinc) are frequently calculated by using water quality criteria or drinking water standards.

This practice is generally applied during the development of industrial wastewater point source permits. This permitting strategy fails to address many key considerations associated with ground water remediations in remote locations, where discharge alternatives are limited. We believe that it is possible for the NPDES discharge limitations for the Medley Farm Site to be established at concentrations so low as to effectively preclude discharge of the treated ground water into the receiving stream without extensive tertiary treatment. This situation could potentially occur for inorganics totally unrelated to the site COCs. Furthermore, NPDES discharge limitations set in this manner would fail to take into account the background conditions of the proposed receiving stream.

Since treated ground water discharge to Jones Creek or its unnamed tributary will only occur over a limited duration of time, we feel that it would be reasonable for the Agency to consider alternative NPDES permitting strategies for this point source discharge. In the event a reasonable NPDES permit can not be obtained, it will be necessary for RMT to pursue other discharge alternatives, including re-infiltration of the treated ground water to the subsurface.

We feel that it is very important for both EPA and SC DHEC to recognize the need for flexibility in establishing reasonable NPDES discharge limitations for the treated ground water effluent. Unreasonable NPDES discharge limitations could very well hinder the overall implementability of the ROD-selected remedy and result in unwarranted costs to the Medley Farm Site Steering Committee.

To address these areas of possible concern, RMT proposes to conduct additional surface and ground water sampling during the Remedial Design. The specific timing and details of these efforts would be described in the forthcoming RD Work Plan. It would be the purpose of these studies to provide sufficient information regarding the background condition of the receiving stream(s) and ensure that the permitted discharge limits are protective of human health and the environment.

These types of field studies would address the issue of treatability from an operations and permitting perspective. Ostensibly, these studies would be conducted by collecting additional samples from site ground water monitoring wells SW-1, SW-3, SW-4, and BW-2 and surface water sampling stations within Jones Creek and its unnamed tributary. The analytical parameter list for these studies would include such items as total and dissolved iron, total and dissolved manganese, total and dissolved aluminum, calcium hardness, total hardness, pH, temperature, alkalinity (P and T), priority pollutant metals, stream flow, and suspended solids.

In summary, we believe that formal Treatability Studies are not required for design of the air-stripping unit The observed levels of VOCs in the ground water at the Medley Farm Site indicate that air-stripping of the affected ground water will be an effective and reasonable VOC-removal technology. While we believe that air-stripping will be capable of achieving the specified remedial objectives, we recognize that treatability studies are needed to be address specific engineering concerns related to operational or permitting concerns. These treatability studies do not require the development of a separate workplan and can be effectively addressed within the text of the RD work plan.

Ralph, I hope that this discussion will assist you and other Agency reviewers in developing an appreciation for the manner in which we hope to address the issue of Treatability Studies at the Medley Farm Site. RMT is experienced in project work of this type and we know what it takes to get the job done. We look forward to working with you and your staff on this project and feel sure that we can count on your cooperation and assistance as we move forward into the RD phase.

If you have any questions or comments, please contact either myself or Steve Webb at your earliest convenience.

Very truly yours,

RMT, Inc.

David G. Nichols

David G. Nichols, P.G.
Project Manager

cc: Medley Farm Site Steering Committee Distribution

ATTACHMENT A

RMT'S Conceptual Approach to the Medley Farm Remedial Design

RMT has successfully conducted a number of related ground water and soil remediation projects in the Piedmont Region of South Carolina. Our general approach to these types of projects is described in this section. A more detailed technical description of a specific project is provided in Attachment B. The project description given in Attachment B discusses a recent project almost identical in scope and approach to the Medley Farm Site.

RMT's ongoing soil and ground water remediation projects in the Piedmont region are, for the most part, under the regulatory oversight of SC DHEC. Most of these remediation projects are similar to Medley Farms in that remediation of affected soils and ground water contaminated by volatile organic solvents are involved. We believe that this region-specific experience will prove to be an invaluable source of information as the Medley Farm project progresses, due to the large degree that this acquired technology and experience is directly transferable to the Medley Farm site.

In this section, we will describe RMT's general approach and use of technology towards remediating VOC-affected soils and ground water. In so doing, we hope to communicate to you our intended approach and vision for the Medley Farm Site.

Submersible Pumping Systems

During one of RMT's initial ground water remediation projects in the Piedmont region, we initiated an interim ground water recovery/treatment program to address high concentrations of VOCs that were observed at an industrial site. This interim ground water remediation system consisted of a network of seven extraction wells, each equipped with a submersible pump, individual control panels and instrumentation to acquire water level readings and provide automated control over the pumps. Ground water from these interim wells was piped to a centralized pipe manifold and delivered to a packed-tower air-stripping unit for treatment. The treated ground water was subsequently discharged under permit to the publicly owned treatment works.

This interim ground water extraction system was initially designed and installed as a part of a "quick-response" remedial action system. For this reason, the extractions wells were designed and installed without the benefit of extensive soils testing and ground water quality assessment/modelling. As a result, RMT was able to accumulate valuable information during this period of time that has lead to the development of the design basis for the full-scale ground water and soils treatment system.

One of the fundamental lessons learned during this period of interim ground water recovery in the Piedmont region was that ground water recovery from weathered saprolite and fractured bedrock is by no means an easy or routine task. The observed drawdown in extraction wells in this region often occurs at a rapid rate and the recovery rates for these wells can be quite slow. Ground water flow rates are generally slow to moderate (10 to 100 feet/year).

Operationally, these region-specific considerations manifested themselves drastically in the overall performance of the submersible pumping system utilized. The submersible pumps used during the interim ground water remediation were found to be constantly cycling on and off in a never-ending response to the constantly fluctuating water levels. The observed well yields were also much less than what had been originally anticipated.

In general, fluid pumps function better during periods of sustained operation than during intermittent operation. Constant on-off cycling is an inefficient way to operate a pump and can lead to troublesome maintenance headaches. There is also no reason that a ground water extraction system has to rely on expensive or otherwise complicated control/sensing systems to provide an efficient means of removing ground water from the subsurface.

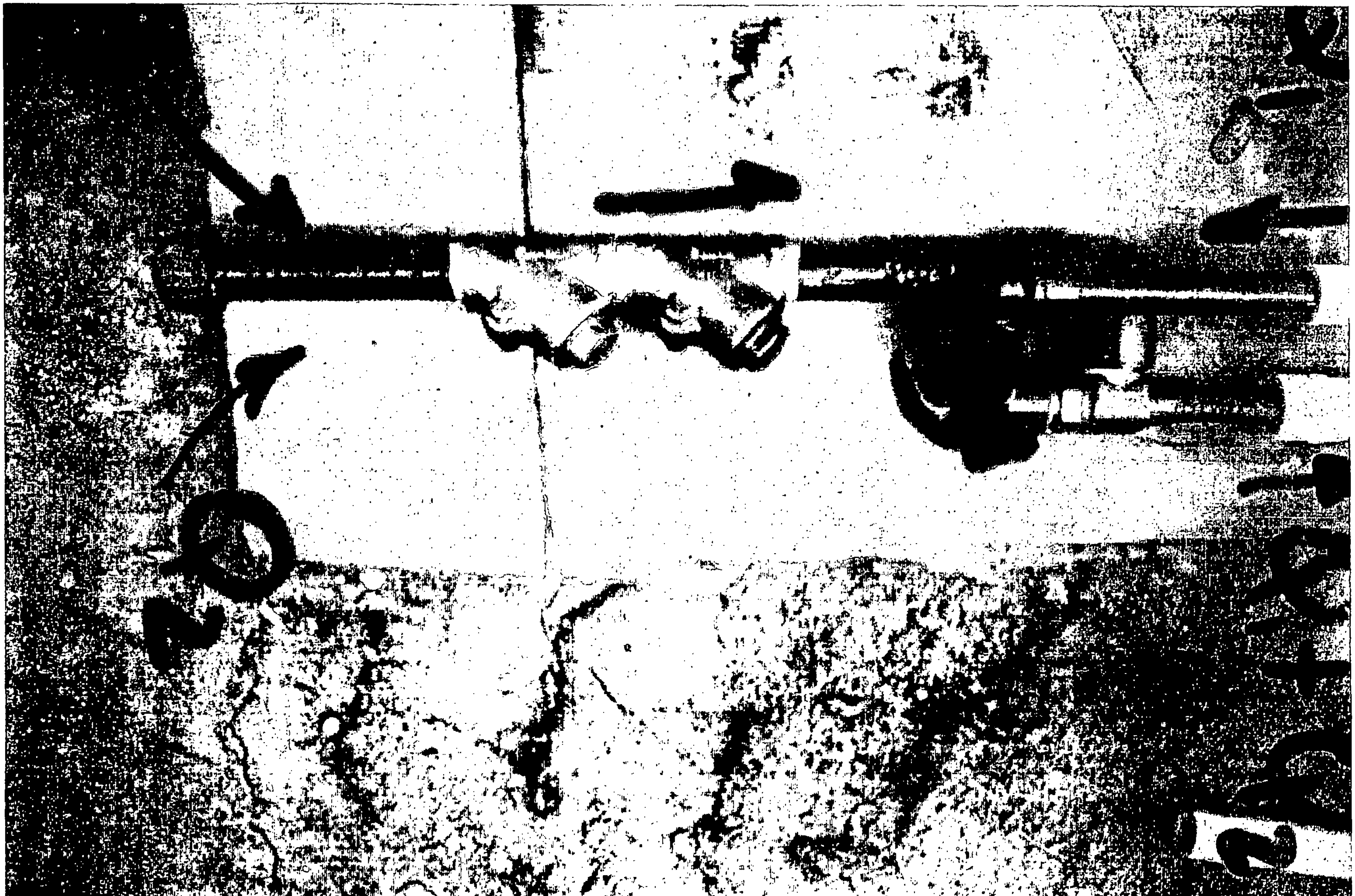
Jet-Pump Ground Water Extraction

After careful consideration of the system performance, RMT developed a unique approach towards extracting ground water from geologic strata where the known recovery rates are slow by the use of a mechanism referred to as a jet-pump. A jet-pump mechanism (refer to photograph 1) is a simple (typically brass or injection-molded plastic) mechanism that has no moving parts and operates using very basic principles of physics. In photograph 1, you should observe that the basic jet-pump mechanism is located near the top-center of the frame (a brass assembly is shown). The basic operating principle of the jet-pump involves movement of a recirculating water stream (Q_1) across the throat of a venturi located inside the brass casting. The flow of water across the venturi creates a negative pressure head that subsequently induces flow (Q_2) from the extraction well upward. This induced flow, Q_2, then passes through a set of two check valves (acting as backflow preventers) and ultimately co-mingles with Q_1. The combined flow (Q_1+Q_2) then moves upward through piping, out of the extraction well and into the main recirculation header.

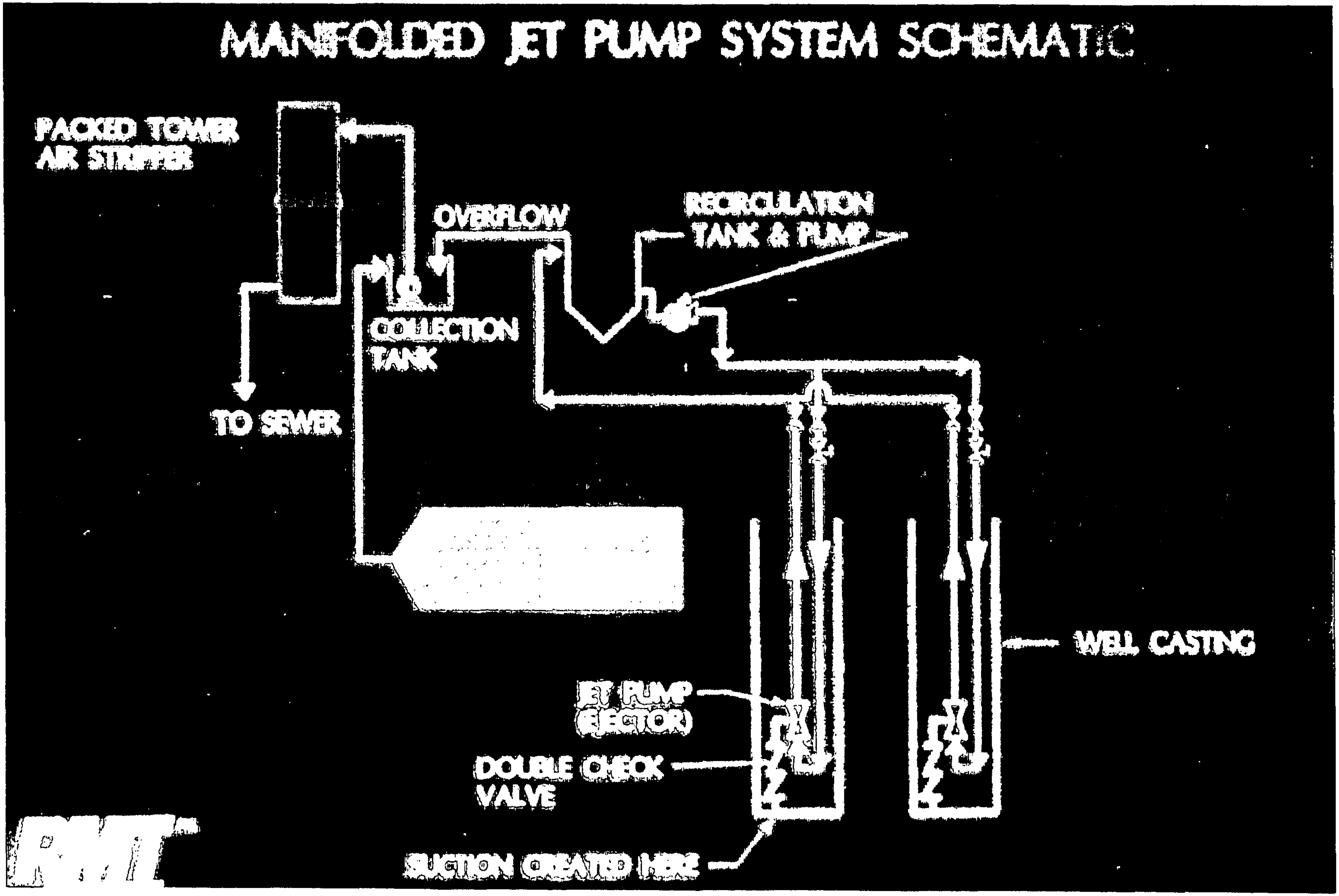
This approach to ground water extraction is classic in its simplicity and practical in that it does not require expensive level controls or process instrumentation. All moving parts are maintained above ground and there are very few elements of the overall system that even require periodic attention. Elaborate control systems are not required since the jet-pump mechanism will continue to function, even if the extraction well runs dry. There is no pump to worry about burning out; the jet-pump mechanism simply continues to create a vacuum and draw air into the system. The negative pressure head created by the jet-pump makes it ideal for working in tandem with a SVE system, a concept discussed later in this report.

Photograph 2 depicts a simplified flow schematic of a manifolded jet-pump system designed to collect and deliver contaminated ground water to an air-stripping tower. The recirculation pump (standard centrifugal pump) for this system is located above-ground near a centrally located recirculation tank. This pump is used to provide the required water flow for each of the individual jet-pump mechanisms. The recirculation pump operates in a continuous mode and is easily maintained and serviced. The size of the recirculation pump is a function of the number of jet-pump mechanisms that are installed and the overall headloss of the collection and delivery system. We are currently operating jet-pump extraction systems utilizing 10-15 wells off a single pump. It is possible to utilize more wells than this, but we have not encountered a project where it was technically justified. The flexibility in the number of the jet-pump wells that can be added to a properly designed system is an inherent advantage for sites requiring ground water remediation. A properly designed system can be easily expanded to include additional extraction wells by simply tapping into the main recirculation header.

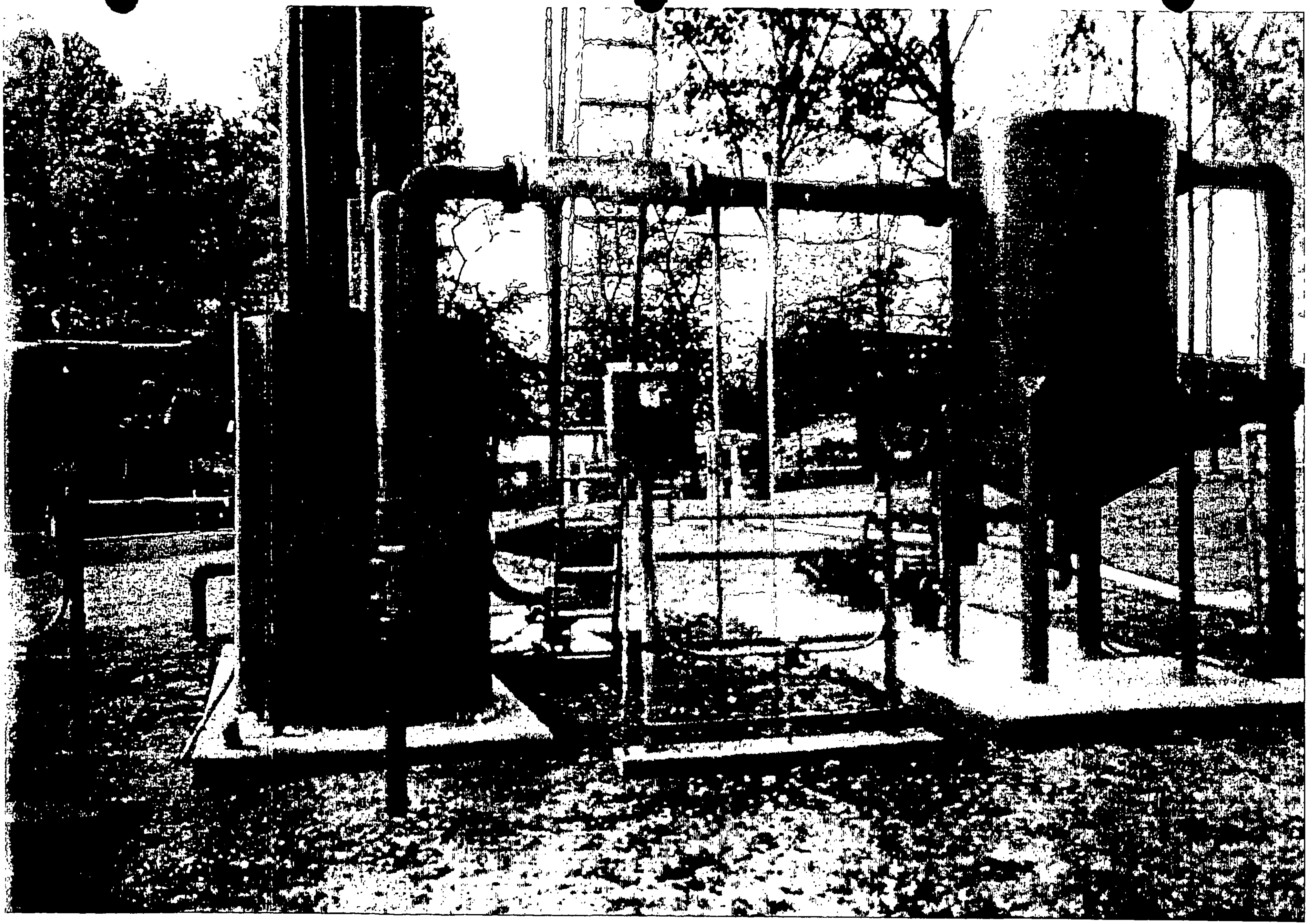
The combined flow from the jet-pump system (Q_1 and Q_2) continually recirculate and discharge into the recirculation tank shown on photograph 2. The recirculation tank serves both as a suction head for the recirculation pump and a volume control for the overall recirculation system. Since the recirculation tank is equipped with an overflow weir, any fluid volume in excess of that which is required to maintain the Q_1 flow rate, will overflow by gravity to the air-stripper collection tank. This volume of water can be measured by open-channel flow measuring devices. Submersible pump(s) are then utilized to lift the contaminated ground water to the air stripper for treatment. Photograph 3 shows the configuration of a manifolded jet-pump system currently in operation at a facility in South Carolina.



Photograph 1 - Jet-Pump Mechanism with Check Valves.



Photograph 2 - Flow Schematic for Jet-Pump System.



Photograph 3 - Manifolded Jet-Pump System in use at Fountain Inn, SC Facility.

Soil Vacuum Extraction (SVE)

RMT has utilized SVE at a number of sites for the same reasons it has been specified at the Medley Farm Site. To achieve the remedial objectives established for the ground water of the Medley Farm Site, it will be necessary to treat affected vadose zone soils to a level where they no longer serve as a reasonable source area for ground water effects.

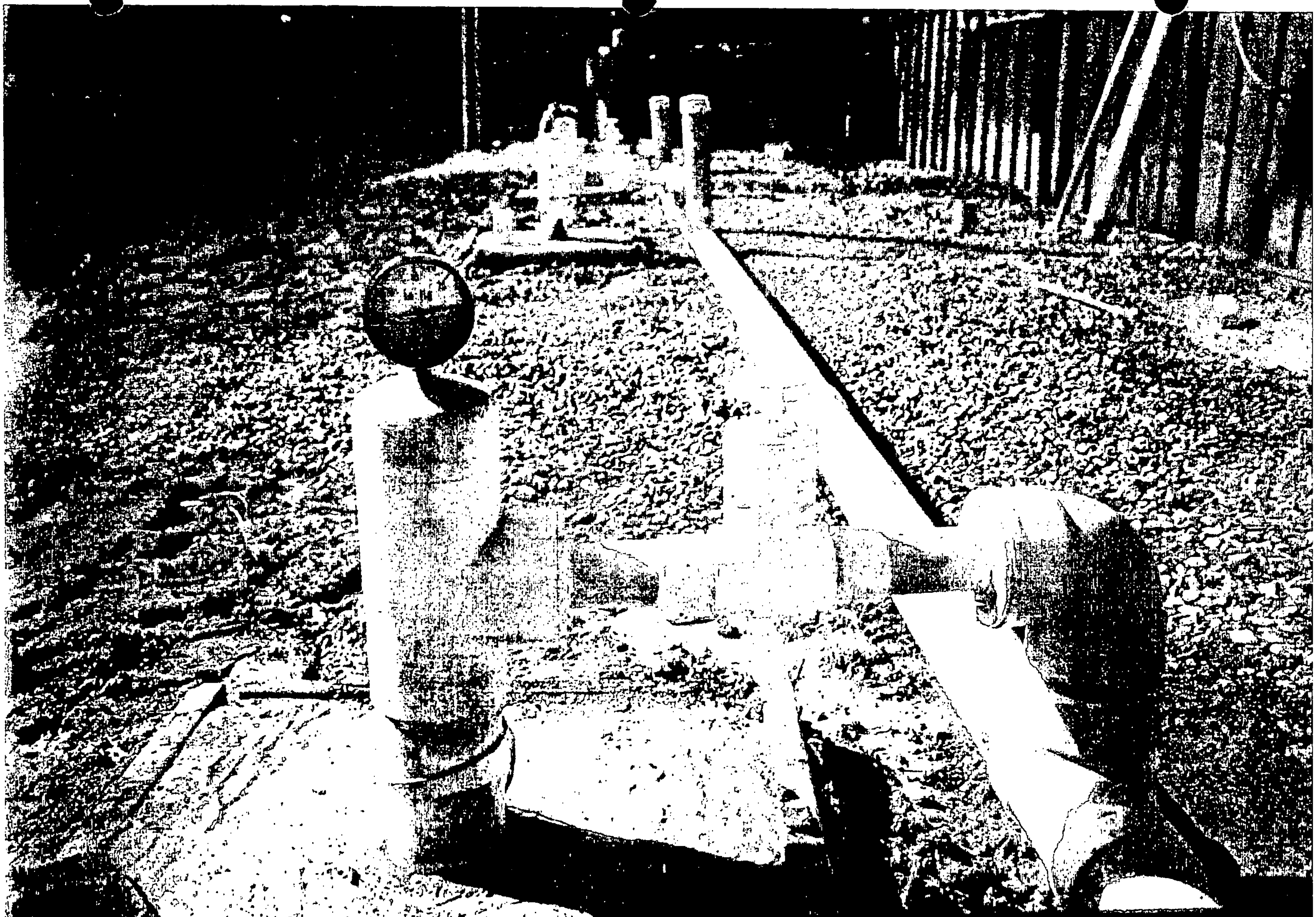
Over the years, RMT has utilized SVE both as a separate remediation technology (photograph 4) and as an integrated component of a combined ground water extraction/soils treatment system (photograph 5). In both cases, we have experienced favorable results in the application of SVE to field problems. We will carefully consider both of these alternatives and others during the remedial design phase.

In photographs 4 and 5, you should also recognize that the vacuum extraction lines are PVC piping running along the ground surface. RMT has elected to install SVE vacuum lines above the ground surface since there is no concern for freezing of the line during the winter months and the system can be more readily inspected and maintained in this manner. Our experience has shown that vacuum leaks quickly manifest themselves as loud shrieks, which are very easy to locate. Vacuum manometers are used in the field to assess the areal extent of the applied vacuum during the remedial action. By using this approach during the Medley Farm RD/RA, we hope to incorporate a degree of pilot testing as we conduct the actual site remediation.

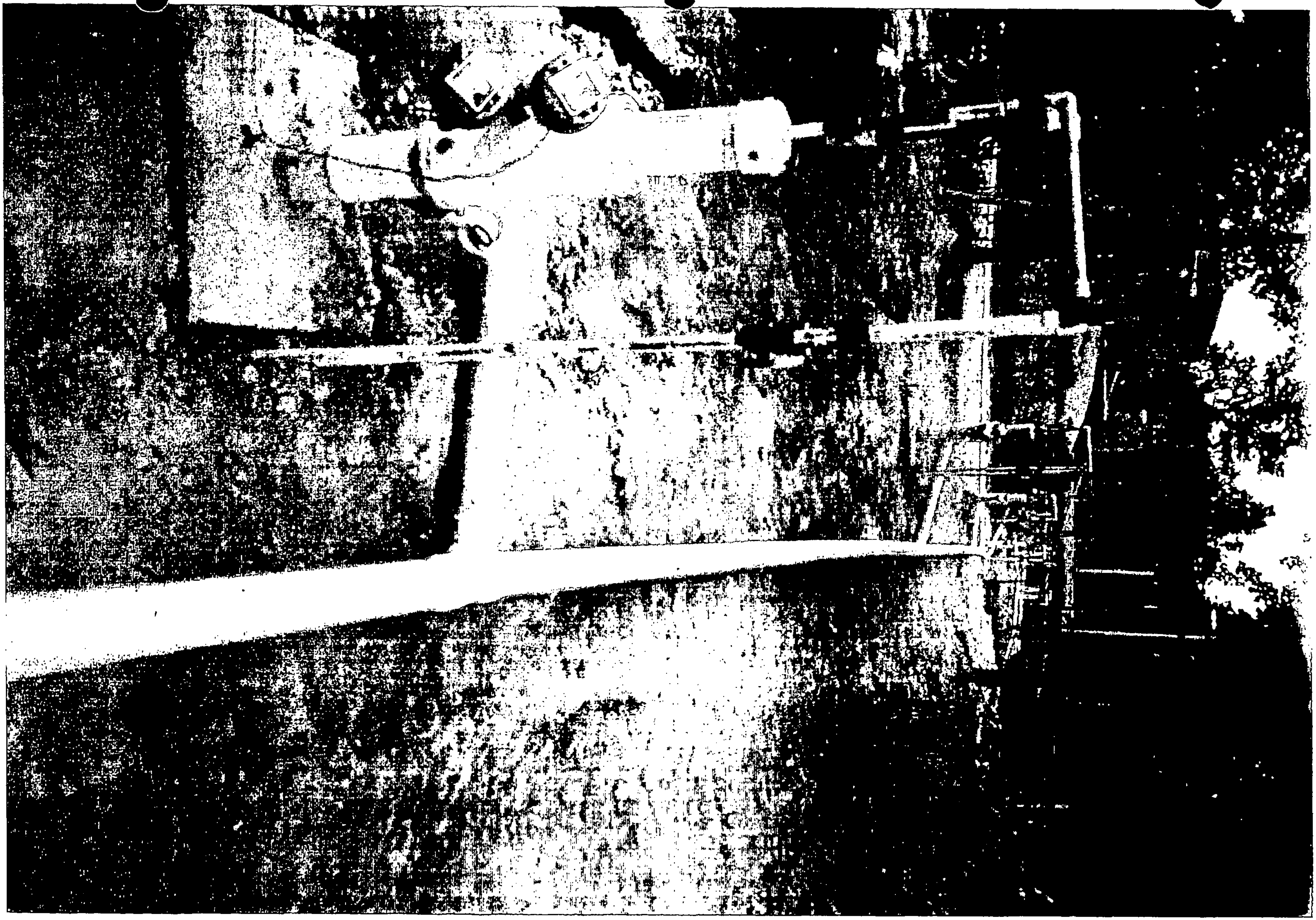
The actual vacuum equipment for SVE is brought to the site in a transportable trailer (photograph 6), which is an important feature. The wording of the ROD suggests to us that the US EPA also recognizes that SVE will require a lesser duration to achieve prescribed remedial clean-up targets than will the ground water remediation efforts. For these reasons, we focus our design efforts towards keeping the SVE system as simple and relocateable as possible.

Integrated Ground Water/SVE Remediation

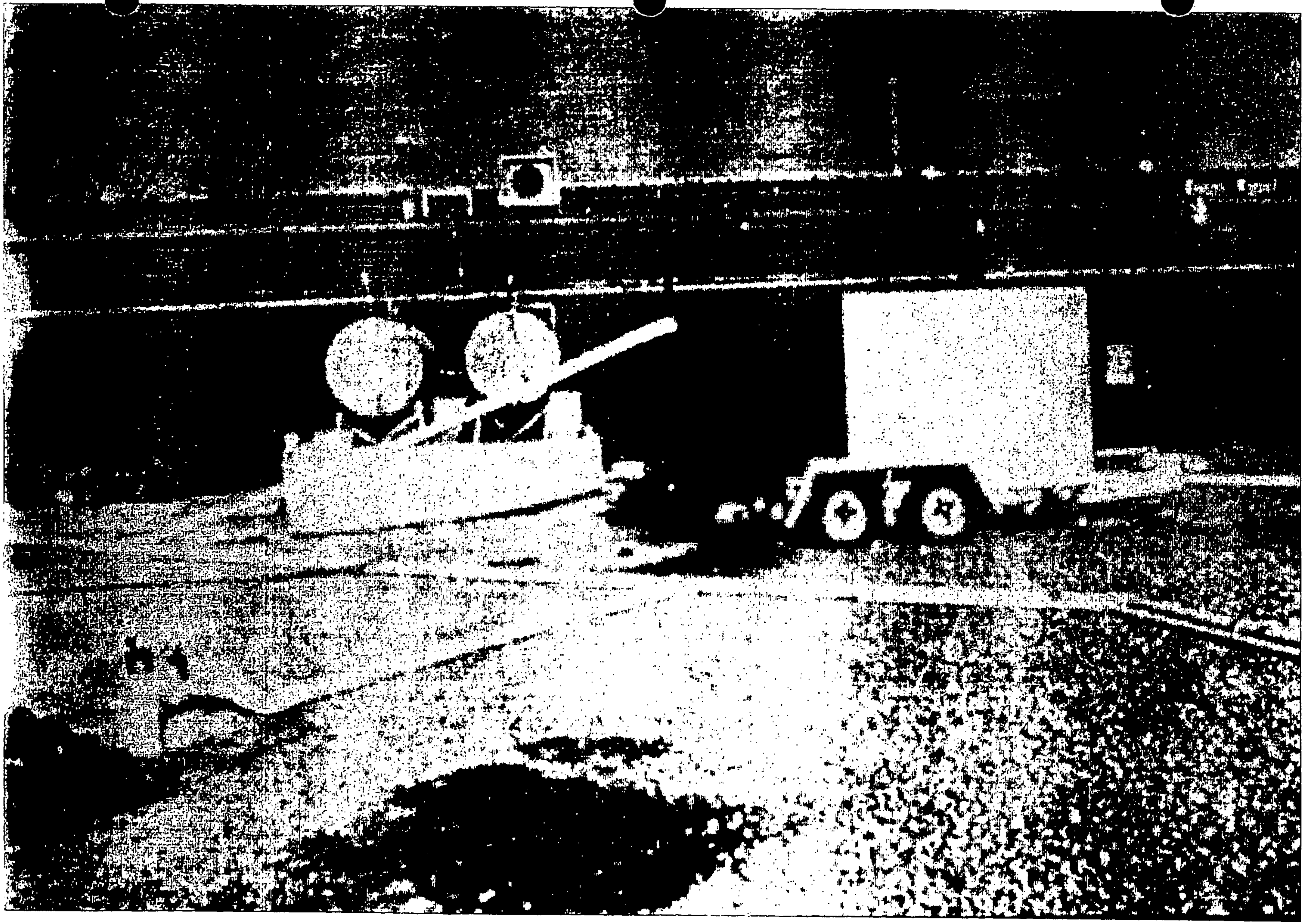
Photograph 7 is a view of an integrated SVE/Jet-pump system and shows how a manifolded jet-pump system can best be utilized in conjunction with SVE. As indicated earlier, the jet-pump, itself, exerts a negative pressure on the subsurface ground water and to a lesser extent the adjacent soils. When SVE is incorporated into the overall design, we have observed a positive, almost "symbiotic" effect between elements of the SVE and ground water extraction systems. As the water table is drawn down and a cone of depression is formed, the SVE system tends to remove additional VOCs from the dewatered soils. In most cases, the applied vacuum significantly enhances the recovery of ground water from the subsurface and we have observed a substantial improvement in overall well yield. RMT will be carefully evaluating the specific site conditions and needs of the Medley Farm Site and work towards developing a remedial design that best addresses these considerations in as reasonable and cost-effective manner as possible.



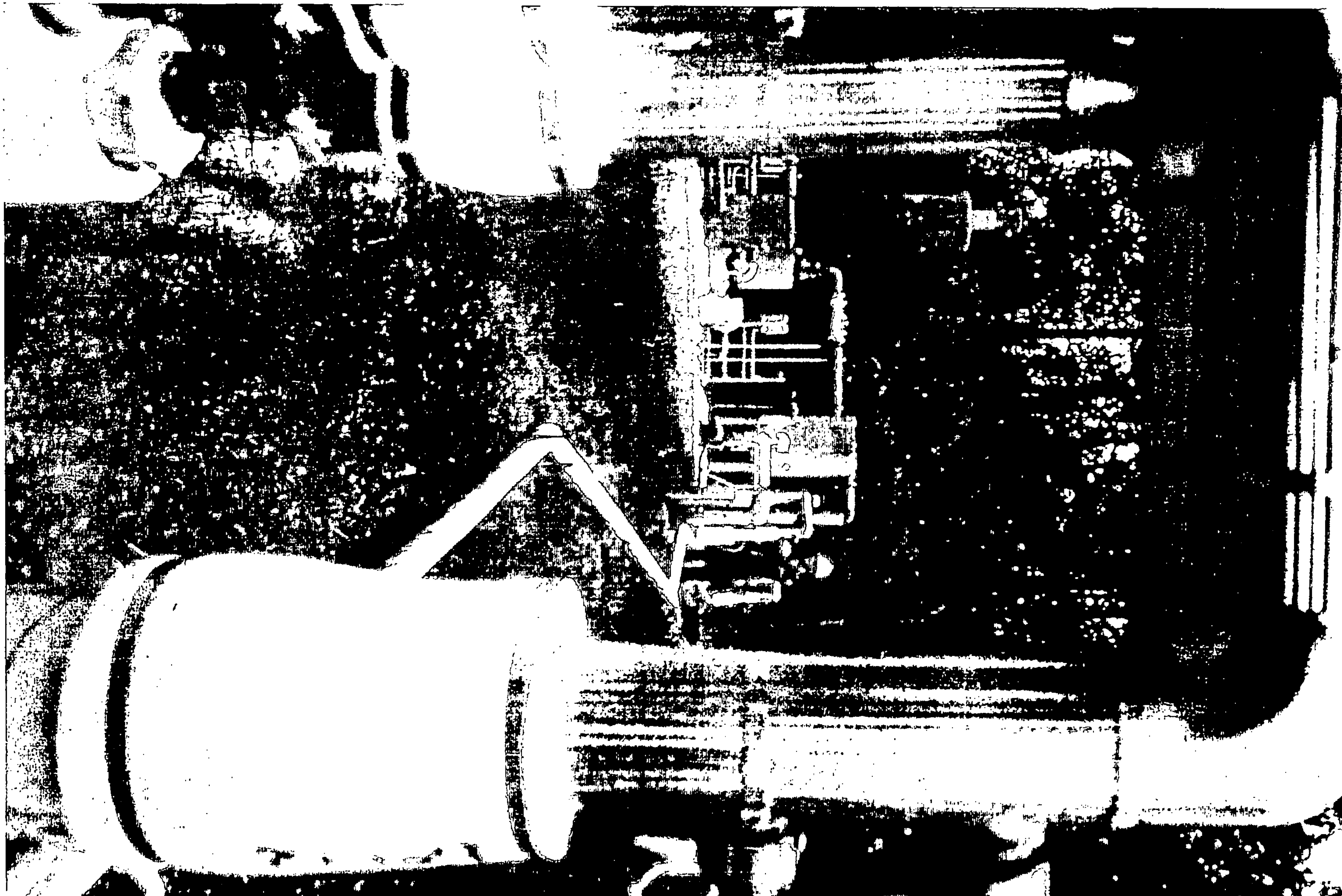
Photograph 4 - SVE System installed at Fountain Inn Site.



Photograph 5 - Integrated SVE and Jet-Pump Extraction System during Construction.



Photograph 6 - Trailer - Mounted SVE Equipment



Photograph 7 - Fully Operational Integrated SVE and Jet-Pump System.

ATTACHMENT B

An Illustration of the Effectiveness of Vacuum Extraction

This facility in South Carolina manufactured dialysis fibers from 1978 to 1984. Tetrachloroethene was used during that time period as a temporary inert fluid injected into the hollow fiber during the preparation of the fiber. Tetrachloroethene was removed from the finished fiber and recycled as a dry cleaning solvent. Three primary tetrachloroethene source areas were identified on the site as follows:

1) A sump in the building basement area

2) Tetrachloroethene handling area

3) Wastewater lagoons

The site lies within the Piedmont Physiographic Province. The geology is typical of the Piedmont - surficial layer of residual soil underlain by saprolite and rock.

The residual soil thickness ranges from approximately three to thirteen feet. Soil types encountered include silty and clayey sands, silty and sandy clay, and sandy silt. Grain size of the sand fraction is predominantly fine to medium. The thickness of the saprolite unit varies from approximately 25 to 80 feet. Soil types encountered include silty sand and silt. Silty sand is by far the predominant soil type within the saprolite.

During October 1986, a vacuum extraction pilot demonstration was performed with vacuum extraction wells in the former tetrachloroethene handling area and vacuum extraction trenches in the former wastewater lagoon area. Based on the favorable results of the demonstration, the vacuum extraction system was expanded in March 1987 to encompass the primary areas of unsaturated soils containing tetrachloroethene.

Since September 1986, the total number of wells has grown to 24 over an area of approximately l.5 acres, and approximately 10,000 pounds (740 gallons) of tetrachloroethene have been removed by vacuum extraction. The tetrachloroethene concentrations in unsaturated soils have decreased to near or below detection levels (0.001 mg/Kg).

Recent analyses of unsaturated soil samples from the former tetrachloroethene handling area and the former lagoon area show levels of tetrachloroethene at or near detection levels (<0.001 mg/kg). Tetrachloroethene levels in these areas generally ranged up to 600 mg/kg prior to vacuum extraction. Also, prior to vacuum extraction, tetrachloroethene levels ranging from 2,000 to 10,000 mg/kg were detected in limited areas within the former tetrachloroethene handling area. Furthermore, decreases in tetrachloroethene concentrations in air extracted by vacuum range from 90 to greater than 99 percent. Thus, tetrachloroethene in the unsaturated soils should no longer leach tetrachloroethene to the ground water. This is further documented by soil leaching tests using a zero headspace method (TCLP).

Area A, which is within the former tetrachloroethene handling area, has been the major source or tetrachloroethene removed by air stripping. Soil samples collected within this area in April 1986 contained from 0.18 to 194 mg/kg tetrachloroethene. Soil samples collected from approximately the same locations in November 1988 contained from less than detection (0.001 mg/kg) to 0.0067 mg/kg. Tetrachloroethene concentrations in the extracted air have also significantly decreased from the wells in this area. For example, tetrachloroethene concentrations in the air from VE-1 have decreased greater than 99 percent, from 4,000 ppm in October 1986 to 12 ppm currently. Tetrachloroethene concentrations in the air from VE-4 have decreased greater than 99 percent, from 5,900 ppm to 11 ppm. Similar trends have occurred in all vacuum extraction wells. Tetrachloroethene concentrations in the air from VE-9 have decreased 95 percent from 2,650 ppm to 142 ppm.

TCLP and compositional analyses of the soils within the vacuum extraction area indicate that the high levels of leachable tetrachloroethene originally present have been removed. Throughout the history of the project, several soil samples have been collected from five representative areas to evaluate the effectiveness of vacuum extraction. The results of the soil analyses are summarized on Table A-1.

Tetrachloroethene concentrations in the air extracted from each vacuum extraction well have significantly decreased. These decreases correspond directly to decreases in leachable tetrachloroethene quantities. Figure A-1 presents typical time series plots from each of the three tetrachloroethene source areas. TE-1 is in the former lagoon area, PW-1 is in the basement area, and VE-1 and VE-9 are in the former tetrachloroethene handling area. The decrease in tetrachloroethene concentrations in extracted air ranges from 90 to 99 percent.

Prior to vacuum extraction, high initial tetrachloroethene levels were detected throughout the unsaturated and saturated soil zones at VE-9 (as indicated by the data for area H-3 on Table A-1). Tetrachloroethene concentrations in the saturated soils at VE-9 ranged up to 9,800 mg/kg. It is likely that the majority of tetrachloroethene currently being removed by vacuum extraction from VE-9 is being volatilized from the dewatered soils. Soil analyses in November 1988 indicate that greater than 99 percent tetrachloroethene has been removed from the unsaturated soils at the VE-9 area. The tetrachloroethene concentration in the air from VE-9 has decreased from greater than 2,000 ppm to a current level of less than 150 ppm, which is a 92 percent reduction.

ATTACHMENT C

Air Stripper Performance Calculations

Figure 1 is a schematic drawing of an air stripper and the following development illustrates the calculation methods used to predict the performance of an air stripper.

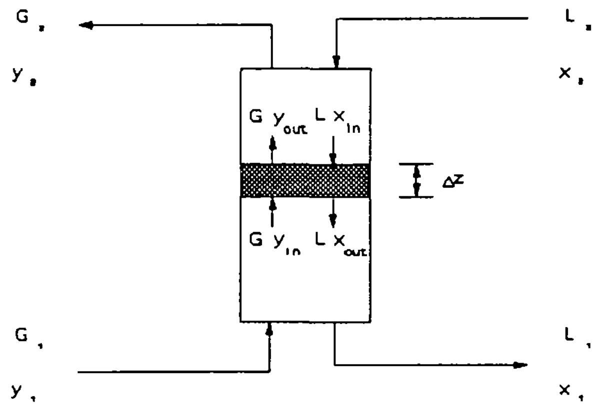


Figure 1: Air Stripper

Material Balance in ΔZ

Input + Generation = Output + Consumption + Accumulation

Generation of mass = 0

The air stripper is in steady state $\therefore$ accumulation of mass = 0

Input = Output

Where, G and L are the molar flow rates

of the gas and liquid;

y and x are the mole fractions of a constituent

in the gas and liquid;

The Material Balance becomes

$$(L\,x)_{in} + (G\,y)_{in} = (L\,x)_{out} + (G\,y)_{out}$$

When the liquid and gas flow rates are constant

$$y = \frac{L}{G}x + y_1 - \frac{L}{G}x_1$$

The operating (mass balance) relationship can be assumed to be linear because the mass transferred from the liquid phase to the gas phase results in a negligible change in the mass flow rate of either stream; therefore, the ratio of the mass flow rates, which is the slope of the operating relationship is constant and the relationship is linear.

Henry's Law has been demonstrated to adequately model the equilibrium behavior of dilute solutions (1). According to Henry's Law, the partial pressure of a component in equilibrium with a dilute liquid solution is linearly proportional to the concentration of the component in the liquid phase. In atmospheric air strippers, the ideal gas law can be applied to the gas phase. Adding Dalton's Law of partial pressures, which states that the partial pressure of a component is its gas phase mole fraction multiplied by the total pressure, to Henry's Law, the following relationship describes the equilibrium in the system (1):

$$y^{*} = m\,x$$

Air stripper operation has been successfully modelled by using mass transfer relationships that assume linear operating and equilibrium relationships (2,3,4,5). The appropriate design relationship as developed by Treybal (1) is as follows:

$$N_{tOL} = \frac{\ln\left[\dfrac{x_2 - \dfrac{y_1}{m}}{x_1 - \dfrac{y_1}{m}}(1 - A) + A\right]}{1 - A}$$

Where, the stripping factor, A, is $\dfrac{L}{m\,G}$

and N_{tOL} is $\dfrac{Z\,K_L a\,P_t\,(1 - x)_{*m}}{L}$

Z is the packed depth of the air-stripping column;

$K_L a$ is the overall mass transfer coefficient based on the liquid phase driving force;

P_t is the total pressure; and

$(1 - x)_{*m}$ is the log average of actual liquid concentration and liquid phase equilibrium concentration at the ends of the column.

For air stripping of dilute solutions, liquid phase mass transfer is usually controlling because the solutions are dilute, component interaction is negligible (2). When liquid phase mass transfer controls,

For air-stripping columns

$$y_1 = 0 \text{ and}$$

$$(1 - x)_{*m} \approx 1$$

$$\therefore \quad N_{tOL} = \frac{\ln\left[\frac{x_2}{x_1}(1 - A) + A\right]}{1 - A}$$

$$\text{Rearranging,} \quad \frac{x_2}{x_1} = \frac{e^{N_{tOL}(1 - A)}}{1 - A} - A$$

$$k_L a \gg k_G a$$

$$K_L a \approx k_L a$$

The Onda correlation (6) has been used to adequately estimate mass transfer coefficients for air-stripping columns (2,4,5).

Onda Correlation

$$K_L \left(\frac{\rho_L}{\mu_L g}\right) = 0.0051 \left(\frac{L}{a_w \mu_L}\right)^{\frac{2}{3}} \left(\frac{\mu_L}{\rho_L D_L}\right)^{-0.5} (a_t D_p)^{0.4}$$

Where, ρ_L *is the liquid density*

μ_L *is the liquid viscosity*

a_w *is the wetted area*

D_L *is the liquid phase diffusivity*

g *is the gravitational constant*

D_p *is the packing diameter*

$$\frac{a_w}{a_t} = 1 - \exp\left[-1.45 \left(\frac{\sigma_c}{\sigma}\right)^{0.75} N_{Re}^{0.1}\ N_{Fr}^{-0.05}\ N_{We}^{0.2}\right]$$

Where, σ *is the surface tension of the liquid*

σ_c *is the surface tension of the packing*

a_t *is the column diameter*

N_{Re} *is the Reynolds Number* $\frac{L}{a_t\ \mu_L}$

N_{Fr} *is the Froude Number* $\frac{L^2\ a_t}{\rho_L^2\ g}$

N_{We} *is the Weber Number* $\frac{L^2}{\rho_L\ \sigma\ a_t}$

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